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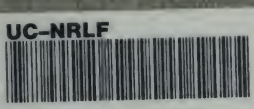

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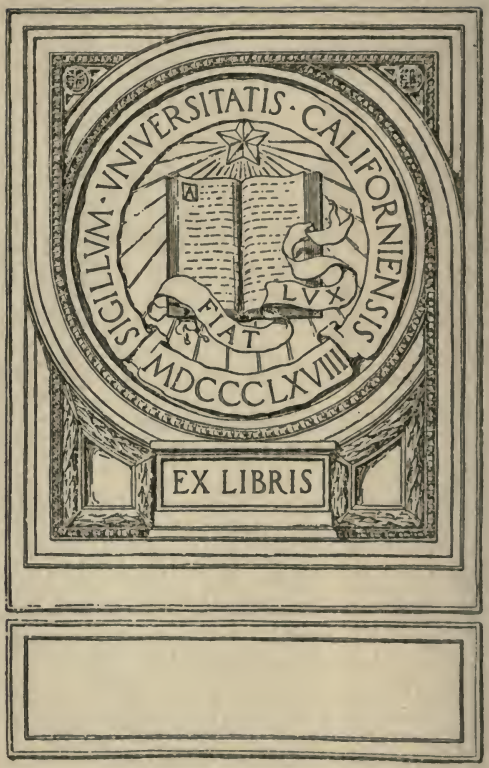
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NOTES ON RECENT OPERATIONS, NO. 3

ARMY WAR COLLEGE

AUGUST, 1917

WASHINGTON

GOVERNMENT PRINTING OFFICE

1917

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War Department
Document No. 655
Office of The Adjutant General.

WAR DEPARTMENT,
WASHINGTON, *August 23, 1917.*

The following Notes on Recent Operations, No. 3, are published for the information of all concerned.

(062.22 A. G. O.)

BY ORDER OF THE SECRETARY OF WAR:

H. L. SCOTT,
Major General, Chief of Staff.

OFFICIAL:

H. P. McCAIN,
The Adjutant General.

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WAR DEPARTMENT,
THE ADJUTANT GENERAL'S OFFICE,
Washington, June 19, 1917.

To all officers of the Army:

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By order of the Secretary of War:

H. P. MCCAIN,
The Adjutant General.

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GERMAN SMOKE-PRODUCING APPARATUS.

Description.—The Germans use smoke-producing apparatus based on the reaction of a mixture of anhydride and sulphuric chlorydrine (in equal parts) on quicklime, which produces a cloud of heavy white smoke.

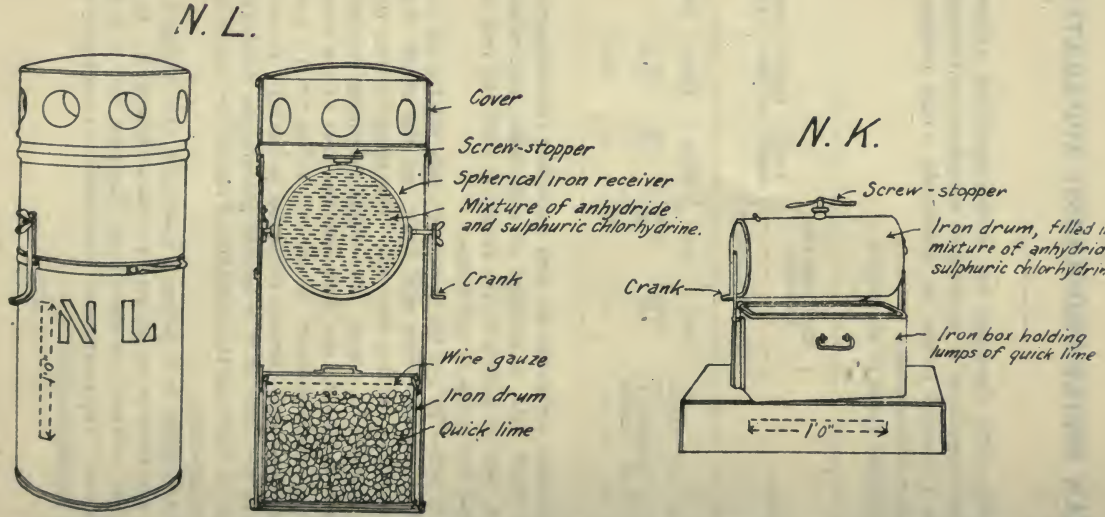
There are three types of apparatus:

Name.	Approximate dimensions.		Total weight.	Weight of lime.	Quantity of acid.
	Height.	Diameter.			
	Meter.	*Meter.*	*Kilos.*	*Kilos.*	*Liters.*
Nebel-trommel "N. T." (smoke drum)	0.74	0.49	95	28.6	21.3
Nebel-topf "N. L." (smoke pot)	.91	.38	69	17.7	12.2
Nebel-kasten "N. K." (smoke box)	.4	.35	54	10.9	8.8

Each generator comprises an iron container (drum-shaped or spherical) filled with a mixture of anhydride and sulphuric chlorydrine, held by pivots on the inside or over the iron drum that contains the lumps of quicklime.

Method of use.—To use the generator, take off the lid of the drum holding the quicklime and draw out the screw stopper from the container holding the acid. The latter is then turned to 180° by means of a crank. The liquid falls drop by drop on a wire gauze, drips onto the lime, and the heat of the reaction volatilizes the smoky product. In the "N. T." or "N. L." generators the smoke escapes through the holes in the lid. To put the apparatus in use place it in a hole in the ground, protecting it from shells. A small earth embankment should be thrown up in front of the generator.

Effect.—According to a German document, the smoke is not poisonous, and there is no danger in passing through it. It may cause a slight irritation to the throat and face, but it is absolutely harmless. The mixture of anhydride and sulphuric chlorydrine is noninflammable.



Nebel-Topf "N. L." (smoke pot) cover; screw stopper; spherical iron receiver; mixture of anhydride and sulphuric chlorydrine; crank; wire gauze; iron drum; quicklime. Nebel-Kasten "N. K." (smoke box) screw stopper; iron drum filled with mixture of anhydride and sulphuric chlorydrine; crank; iron box holding lumps of quicklime.

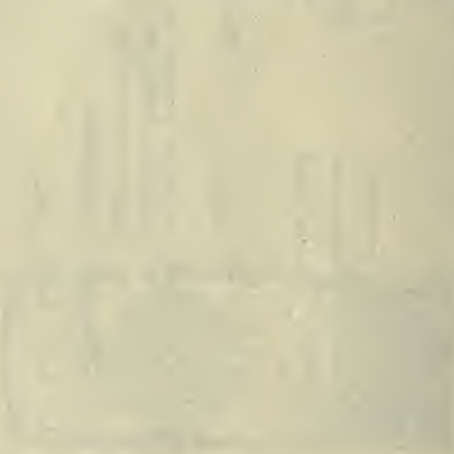
An "N. L." and an "N. K." generator were tested on a day when the velocity of the wind was 13 kilometers per hour. The following results were obtained:

The "N. L." generator produced a very large and very opaque cloud of white smoke, which traveled more than 3.5 kilometers. The emissions of smoke were reduced to a quarter of their original volume at the end of 4 minutes, and disappeared practically entirely at the end of 8½ minutes.

"*N. K.*" *generator.*—A smaller cloud was less rapidly formed than in the preceding case. It lost about one-half its original volume at the end of 4 minutes, but continued for 16 minutes.

The "N. T." generator is said to be twice as effective as the "N. L." generator.

Use.—The German documents say that this apparatus permits defensive and offensive barrages to be made of smoke. Near the front operations can be masked. Works in the rear can be temporarily hidden from aircraft.



THE ORGANIZATION OF AN INFANTRY BATTALION AND THE NORMAL FORMATION FOR THE ATTACK.

(Issued by the General Staff, April, 1917.)

PART I. ORGANIZATION OF AN INFANTRY BATTALION.

(Extracts from O.B/1919, d/–7.2.17, issued by G.H.Q., British Armies in France.)

1. *Necessity of uniformity of organization.*—In order to insure the necessary degree of uniformity of training and tactical method throughout the army, it is necessary that there should be similarity of organization in all battalions. The following instructions are therefore issued.

2. *Battalion.*—The battalion will continue to consist of—

(*a*) Battalion headquarters;

(*b*) 4 companies, consisting of 4 platoons of 4 sections each.

3. *Battalion headquarters.*—In addition to the personnel shown in war establishments as forming part of the battalion headquarters, certain other personnel will be attached. This personnel, which is principally employed on administrative duties, will be temporarily detached from companies whilst so employed, but will remain on the establishment of the companies for accounting purposes. A headquarters company as such will not be formed. The detail of the personnel included in the battalion headquarters is given in Appendix I. The total should not exceed 150 other ranks.

The personnel composing the battalion headquarters can conveniently be divided into two categories, namely, the fighting portion and the administrative portion. The former will be grouped into sections, each under a commander. The strength of the latter will not exceed 80 other ranks.

4. *Companies.*—Each company will consist of—

(*a*) Company headquarters and

(*b*) 4 platoons.

Company headquarters, the strength of which should not exceed 14 other ranks, will be composed entirely of fighting troops, and will be formed as a section under a commander.

5. *Platoons.*—The organization of a platoon is given in S.S. 143.

6. The organization outlined above is designed to create a fighting machine composed solely of fighting ranks and distinct from the necessary administrative establishment.

7. The essence of this organization is—

(*a*) That the platoon should constitute a unit for fighting and training, and should consist of a homogeneous combination of all the weapons with which the infantry is now armed;

(*b*) That specialists should all be with their platoons and companies, except such as may be required at battalion and company headquarters either for purposes of fighting or for instructional duties;

(*c*) That every portion of the battalion, including the fighting portion of battalion headquarters and company headquarters, should consist of a certain number of permanently formed units, namely sections, each under its own commander;

(*d*) * * * * *

(*e*) That every man is available for working and carrying parties, irrespective of the weapon with which he is armed;

(*f*) That one Lewis gun with its detachment is allotted to each platoon. Although this will be the normal organization, it may often be advisable in dealing with particular tactical situations to allot a second Lewis gun to a platoon, or to withdraw temporarily one, two, or more of these guns from platoons for special tactical employment under the orders of company or battalion commanders. It is to be clearly understood that the normal organization is not to interfere with any such temporary special grouping or employment as circumstance may render desirable.

NOTE.—Paragraph 5, page 17, of S. S. 135, "Instructions for the training of divisions for offensive action," will be amended accordingly.

8. In order to meet the varying conditions under which battalions serve, to allow of more flexibility as regards the number of men detached for extra regimental employ, and to meet the case of heavy battle casualities, a maximum and a minimum strength of 28 and 44 O.R., respectively, have been laid down for the platoon in S.S. 143.

PART II. THE NORMAL FORMATION FOR THE ATTACK.

I. *General principles of the formation.*—In the special circumstances of present warfare it has become necessary to modify the provisions of section 114, Chapter IX, "Infantry training" in so far as the attack is concerned, and it is advantageous, under existing conditions, to lay down a normal formation for the attack.

The normal formation described below is one which has frequently been employed with success in recent fighting; it is simple and adaptable to the varying conditions of trench-to-trench attack. It should also prove suitable to most conditions of open warfare.

So far as the platoon is concerned, the formation described should be applicable to most circumstances and it should seldom be necessary to depart therefrom, while as regards the battalion it aims at elasticity.

The platoon is to be regarded as the unit in the assault. The frontage of an infantry battalion in the trench-to-trench attack may range from 200 yards, against a highly organized position, to 600 yards or more, against one less highly consolidated.

II. *Application of weapons.*—The weapons now under the hand of a platoon commander should be arranged according to their various peculiarities. That is to say, the rifle and bayonet and the bomb, being the most effective offensive weapons, should be placed as far forward as possible, closely supported by the rifle grenade, which may be regarded as the "howitzer" of the platoon, and by the Lewis gun, which is the weapon of opportunity.

Each platoon will therefore normally be disposed in two lines, bombers and riflemen in the front line, rifle bombers and the Lewis gun[1] in the second line. These two lines will constitute one wave irrespective of "Moppers-up." (See Pl. "A.")

Further, it has been found convenient as a general rule for the company to be formed on a two-platoon frontage.

The platoon, therefore, should normally be formed in two lines, constituting one wave, and the company in two waves. (See Pl. "B.")

In this connection it can not be too often urged, firstly, that in the assault every man is a bayonet man, excepting No. 1 of the Lewis gun; secondly, that every man is a bomber; and thirdly, that every man in rifle sections is also trained to be either a Lewis gunner or a rifle bomber, with a view to replacing casualties in men armed with those weapons.

III. *Intervals and distances.*—Intervals between men should usually be 4 to 5 yards.

The distance between lines should be 15 to 25 yards and that between waves 50 to 100 yards; to avoid the rear waves being caught in the enemy's barrage, these distances may be reduced to meet the requirements of the moment. Rear waves should move in sections in artillery formation.

IV. *Moppers-up.*—"Moppers-up" should follow the second line of a wave. (See Pls. "A," "B," "C," "D," and "E.") It is considered preferable to find them, *when possible*, from the platoons and companies whose objectives they are to clear. If, however, the numbers required for clearing these objectives are so great as to deplete unduly the platoons or companies to which they are allotted, moppers-up must be found from another company or possibly another battalion. This case will usually occur when attacking a highly organized position at the commencement of an offensive.

V. *Allotment of objectives.*—Each wave must be allotted a definite objective, and each component part of each line should have a definite duty to perform according to the weapon with which it is armed. Thus, in the trench-to-trench attack, if the platoon is given one objective, the company would have two objectives, and the battalion two or more. In this way it is

[1] This in no way contravenes the provisions of paragraph 7 (*f*) of Part I, or par. 29 in "Notes on the tactical employment of machine guns and Lewis guns," dated Mar., 1916.

possible to insure that troops are distributed in depth on attaining their objective and that the frontage of any commander is not unduly extended.

VI. *The assault.*—The assault may be carried out either by—

(i) the leading wave going straight to the farthest objective, rear waves following it to nearer objectives in succession (see Pl. "C");

or by

(ii) the leading wave being directed to a near objective, rear waves passing through it to those farther away, i. e., "leapfrog." (See Pl. "D.")

In cases where there are only two objectives the first-mentioned method is usually preferable. (See Pl. "E.")

In cases, however, where there are more than two objectives either method may be employed.

In deciding which method to adopt, a guiding factor is the distance between the various objectives.

If there is sufficient room for our artillery barrage to halt on, or short of, the farther objective, so as to afford time for the rear waves to close up under it by passing through the leading waves, the second method will be preferable. This method simplifies the organization of "moppers-up." (See Pl. "D.")

If there is not sufficient room for our artillery barrage to halt as above indicated it will usually be necessary to adopt the first method. (See Pl. "C.")

It is necessary to remember the undesirability of the barrage crossing an objective before the waves told off for its capture have closed up under the barrage.

VII. *Plates and notes.*—Five plates are attached, with explanatory notes, showing—

Plate A.—A platoon in one wave of two lines.

Plate B.—A company in two waves of two lines each.

Plate C.—A battalion with four objectives, the first wave being directed to the farthest.

Plate D.—A battalion with four objectives, the first wave being directed to the nearest objective, rear waves passing through; that is to say, "leapfrog."

Plate E.—The battalion on a broader front, with two objectives, the first wave being directed on the farthest objective.

VIII. *Carriers.*—Provision for immediate requirements in grenades and ammunition is made in each section of platoons; requirements over and above these must be met by parties from other platoons, companies, or battalions as best suits the case.

APPENDIX I.

Battalion Headquarters.

OTHER RANKS.

Fighting portion:	Administrative portion:
Sergeant-major.	Quartermaster sergeant.
Clerks.	Company quartermaster sergeants.
Gas personnel.	Storemen.
Signalers.	Transport establishment.
Runners.	Shoemakers.
Pioneers.	Tailors.
Stretcher bearers.	Butchers.
Cooks.	Cooks.
Batmen.	Grooms.
	Batmen.
	Instructional establishment.

AMENDMENTS (APRIL, 1917).

(Issued by the General Staff, May, 1917.)

The following amendments are made:

1. Page 1 (title-page), line 4 from bottom. *For* "O.B./1914/T." *substitute* "O.B./1919/T."

2. Page 4, lines 6 and 7. *Delete* "it is advantageous, under existing conditions,".

3. Page 4, line 6 from bottom, and page 9, line 17. *After* "No. 1," *insert* "and No. 2".

4. Pages 6 and 7. *For* Appendices I and II, *substitute* Appendices I (A), I (B), I (C) and II as follows:

Appendix I (A).

BATTALION HEADQUARTERS.

Fighting portion.		*Fighting portion*—Continued.	
Officers:		Officers:	
Commanding officer	1	Signalling officer	1
Second in command	1	Bombing officer	1
Adjutant	1		6
Lewis gun officer	1	Other ranks:	
		Sergeant major	1
		Orderly room clerk	1

Fighting portion—Continued.

Other ranks—Continued.

Gas	2
Signalers	13
Stretcher bearers	4
Runners	9
Pioneers	11
Cooks	2
Batmen	6
	49
Balance to be made up by additional stretcher bearers, runners, police, or scouts, at the discretion of battalion commanders	21
Total	70

Administrative portion.

Officers:

Assistant adjutant	1
Quartermaster	1
Transport officer	1
	3

Fighting portion—Continued.

Other ranks:

Quartermaster sergeant and storemen	3
Company quartermaster sergeant and storemen	8
Transport establishment and grooms	45
Shoemakers	3
Tailors	3
Butchers	2
Postman	1
Cooks	2
Batmen	3
	70
Balance to be made up by additional shoemakers, tailors, cooks, transport establishment, police, sanitary men, or watermen, at the discretion of battalion commanders	10
Total	80

Appendix I (B).

COMPANY HEADQUARTERS.

Company sergeant major	1
Signalers	4
Runners (including 1 batman)	4
Batman or cook	1
	10
Balance to be made up by additional stretcher bearers, runners, or scouts, at the discretion of company commanders	4
Total	14

Appendix I (C).

PLATOON HEADQUARTERS.

Platoon sergeant		1
Signaler	1	
Runner	1	
Batman	1	
		3
Total		4

Note to Appendices I (A)–I (C).—These numbers do not include those mentioned in S. S. 135, p. 58, "Numbers to be left behind when the battalion takes part in the attack," as it should always be possible to replace those left behind by an equivalent number of men withdrawn from classes, extra regimental employ, etc.

Appendix II.

NUMBERS TO BE LEFT BEHIND WHEN THE BATTALION TAKES PART IN THE ATTACK.

In each battalion:	Per battalion.	
Company sergeant majors	2	
33 per cent signalers	[1] 10	
33 per cent runners	[1] 13	
Gas instructor	1	
Bombing instructor	1	
Lewis gun instructors	2	
Any other instructors in special work, such as dugouts	3	
Total	32	32
In each company:		
Sergeant	1	
Corporal	1	
Lance corporal	1	
Total	3	12
In each platoon:		
Rifle bomber	1	
Scout and sniper	1	
Lewis gunners	2	
Total	4	64
Grand total		108

[1] If up to full strength.

Other ranks.

Establishment of a battalion, including attached 971

	Fighting.	Administrative and employed.	Fighting.	Administrative and employed.
Battalion headquarters:				
Fighting portion	70		70	
Administrative portion		80		80
4 company headquarters of 14 each	56		56	
16 platoons:				
Of 44 each	704			
Of 28 each			448	
Sick and extra regimental employ and other noneffectives		61		317
	830	141	574	397
	971		971	

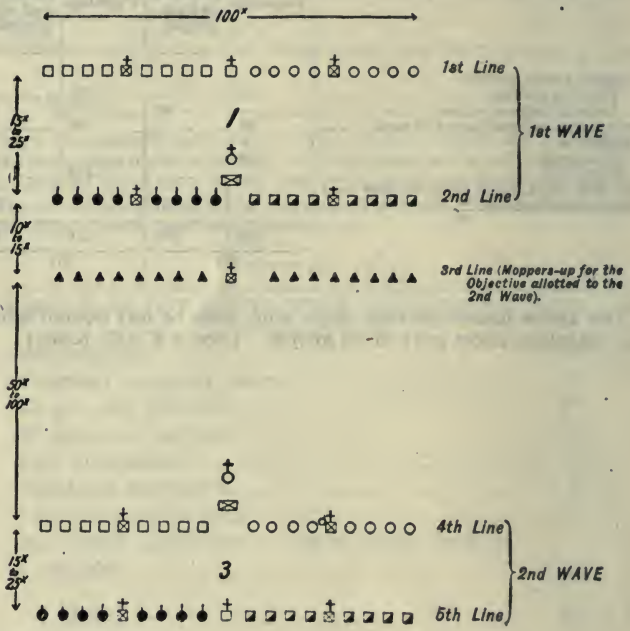
The above figures include those who must be left behind when the battalion takes part in an attack. (See S.S. 135, p. 58.)

PLATE "A."

THE PLATOON.

Taking an average strength of 36 other ranks and headquarters at 4 other ranks.

(Showing 2 platoons in 2 waves, with the right the outer flank.)



KEY.

- Platoon commander.
- Platoon sergeant.
- Section commander.
- Rifleman.
- Lewis gunner.
- Bomber.
- Rifle bomber.
- Mopper up.
- Platoon H. Q.

NOTES.

Two platoons are depicted showing the different positions of leaders in first and second waves.

The platoon is the unit in the assault, moves in one wave of two lines, and has one definite objective.

Every man is a rifleman and a bomber, and in the assault, with the exception of the No. 1 of Lewis gun, fixes his bayonet. Men in rifle sections must be trained either to the Lewis gun or rifle grenade.

Bombing and Lewis gun sections are on the outer flank of platoons.

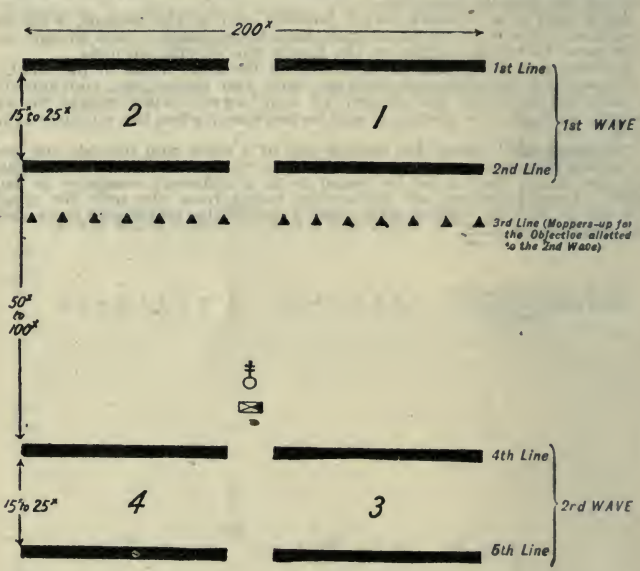
In assembly the distances between lines and waves may conveniently be reduced to lessen the danger of rear waves being caught in the enemy's barrage; the distances will be increased when the advance takes place.

"Moppers up" follow the second line of a wave and precede the unit for which they are to mop up. *See* plates "C" and "D." If the numbers are large, they must be found from a different company or battalion. Small numbers are preferably found from the unit for which they are to mop up. They must wear a distinctive badge and have their own commander.

PLATE "B."

THE COMPANY.

Taking 4 platoons at an average strength of 36 other rank each, and company headquarters at 14 other rank.



KEY.

Company commander.

Company headquarters.

Platoon (in two lines).

Moppers up.

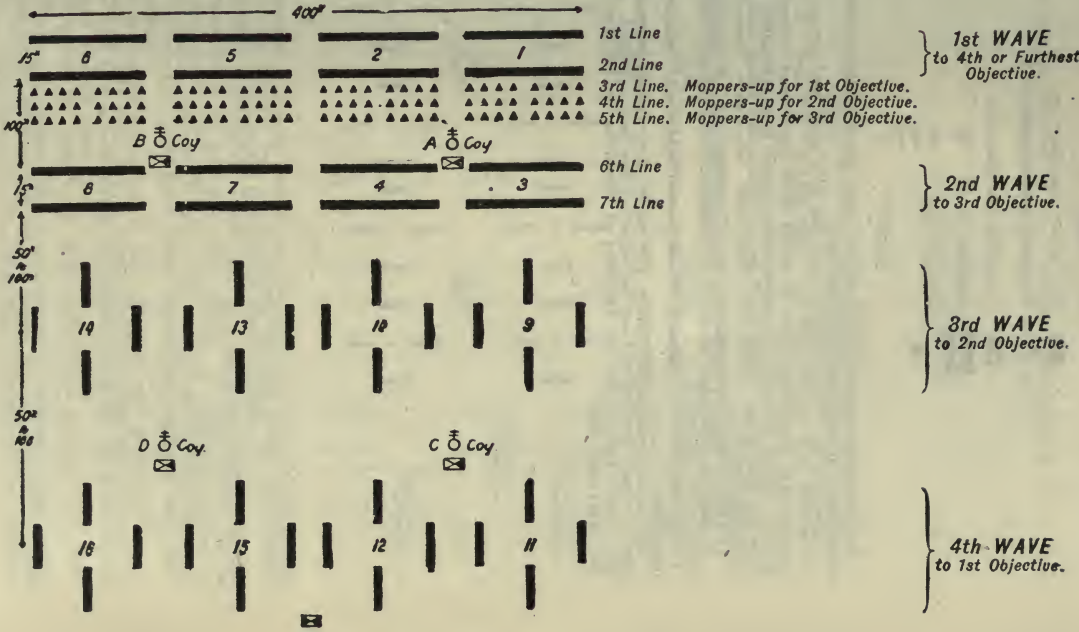
NOTES.

The company moves in two waves, has two objectives, and is distributed in depth.

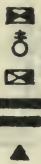
"Moppers-up" follow the second line of a wave and precede the unit for which they are to mop up. (See Pls. C and D.) If the numbers are large they must be found from a different company or battalion. Small numbers are preferably found from the unit for which they are to mop up. They must wear a distinctive badge and have their own commander.

Taking 16 average platoons of 36, 4 company headquarters of 14 and battalion headquarters of 70 other ranks.

Four objectives.—First wave to fourth objective, i. e., farthest.
Second wave to third objective.
Third wave to second objective.
Fourth wave to first objective.



KEY.



Battalion Headquarters.

Company commander.

Company headquarters.

Platoon.

Moppers up.

NOTES.

The battalion moves in four waves, each direct to its objective, and is distributed in depth on attaining them.

"Moppers up" follow the second line of a wave and precede the unit for which they are to mop up. (See plates "C" and "D.") If the numbers are large they must be found from a different company or battalion. Small numbers are preferably found from the unit for which they are to mop up. They must wear a distinctive badge and have their own commander.

In this instance the organization of "moppers up" is complicated.

It may be advisable to detail a company from another unit as a reserve to the battalion.

This formation is capable of easy modification to deal with three objectives.

Battalion headquarters does not move in a trench-to-trench attack until a report is received that the objective has been captured. (See S. S. 135, "Instructions for the Training of Divisions for Offensive Action," Sec. XIII, par. 3.)

PLATE "D."

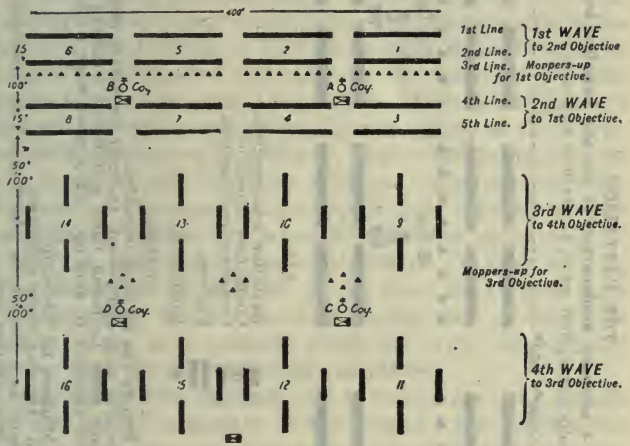
THE BATTALION.

Taking 16 average platoons of 36, 4 company headquarters of 14, and battalion headquarters of 70 other ranks.

KEY.

- Battalion headquarters.
- Company commander.
- Company headquarters.
- Platoon.
- Moppers up.

Four objectives: First wave to second objective.
Second wave to first objective.
Third wave to fourth objective.
Fourth wave to third objective.
i. e.—Leap frog.



NOTES.

The battalion moves in four waves, the first two waves to the nearest objectives and the last two waves passing through to the two farthest objectives, and is distributed in depth on attaining them.

"Moppers up" follow the second line of a wave and precede the unit for which they are to mop up. (See plates "C" and "D.") If the numbers are large, they must be found from a different company or battalion. Small numbers are preferably found from the unit for which they are to mop up. They must wear a distincitve badge and have their own commander.

In this case the organization of the "Moppers up" is simple.

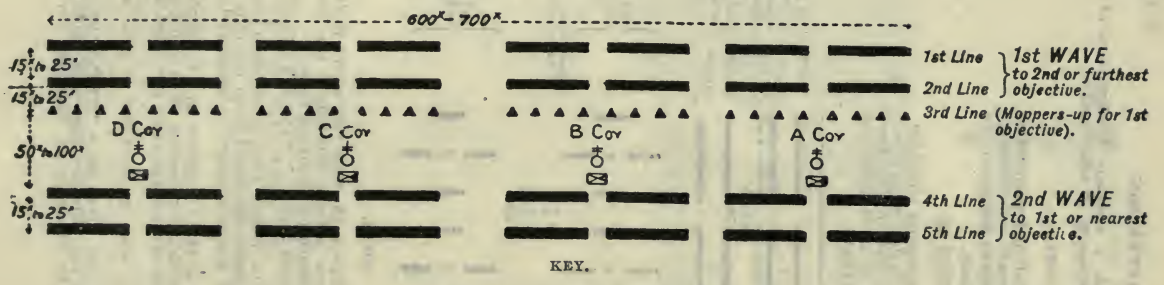
It is not usually necessary to detail a reserve from another unit, because the first and second waves can reform after the third and fourth have passed through them.

This formation is capable of easy modification to deal with three objectives.

Battalion headquarters does not move in a trench-to-trench attack until a report is received that the objective has been captured. (See S.S. 135, "Instructions for the Training of Divisions for Offensive Action," Sec. XIII, par. 3.)

THE BATTALION.

Taking 16 average platoons of 36, 4 company headquarters of 14, and battalion headquarters of 70 other ranks.
(2 objectives, first wave, to farthest objective.)



KEY.

- Battalion headquarters.
- Company commander.
- Company headquarters.
- Platoon.
- Moppers up.

NOTES.

The battalion moves in two waves, the first to the farthest objective.

"Moppers up" follow the second line of a wave and precede the unit for which they are to mop up. (See Plates "C" and "D.") If the numbers are large they must be found from a different company or battalion. Small numbers are preferably found from the unit for which they are to mop up. They must wear a distinctive badge and have their own commander.

In this case the organization of the "Moppers up" is simple.

Companies are distributed in depth on attaining their objectives.

It may be possible to keep one company as a reserve, in which case the formation is easily adaptable; if this is not possible, a company must be detailed from another unit.

Battalion headquarters does not move in a trench-to-trench attack until a report is received that the objective has been captured. (See S.S. 135, "Instructions for the Training of Divisions for Offensive Action," Sec. XIII, par. 3.)

NOTES ON THE USE OF TANKS AND ON THE GENERAL PRINCIPLES OF THEIR EMPLOYMENT AS AN ADJUNCT TO THE INFANTRY ATTACK.

(Issued with special reference to the "Mark IV," 1917, pattern.)

1. With tanks, as with any other arm, satisfactory results can only be obtained by the close cooperation of all arms. Although the employment of tanks as an adjunct to offensive operations is still to a great extent in an experimental stage, it is necessary for all commanders and subordinate leaders of all arms to realize the limitations and capabilities of tanks, and to know the general principles of their employment, so far as these principles can be laid down at present. This is all the more necessary as occasions will inevitably arise (as the number of tanks in this country increases) when troops will be required to operate with tanks without any previous experience or training.

2. (*a*) The radius of action of the Mark IV tank and the limit of endurance of its crew is not more than about eight hours, this period being reckoned from the time of departure from and return to a position where the crew can rest and where the tank can be overhauled and refilled.

Its pace varies from one-half mile to 4 miles per hour, according to the nature and state of the ground. For purposes of calculation its average pace, when fighting under favorable conditions, may be taken at about 2 miles per hour.

(*b*) The Mark IV tank can cross trenches 9 to 10 feet wide, can surmount a perpendicular obstacle 4 feet high, and move up or down a slope of 1 in 2.

So long as the bottom is hard, mud or water to a depth of 2 feet or so is no bar to its progress; but, owing to its weight, ground that has been very heavily shelled or is very sodden to a considerable depth is unfavorable to its employment.

(*c*) Wire entanglements do not form any obstacle to tanks, but the passage of a single tank will only, as a rule, flatten two passages 2 feet wide through the wire. The passage by infantry in single file may therefore be made easier, but the wire remains more or less an obstacle.

Tanks can pass easily through thick hedges or thick woods composed of small trees, but large stumps of broken trees are difficult to see and form a serious obstacle to tanks.

In villages they can operate with success so long as the streets are recognizable, but when the village is reduced to heaps of rubble, tanks are liable to get ditched in the cellars.

(*d*) Although the Mark IV tank has an improved silencer, it can still be heard when in movement within 250 yards unless the noise is covered by a certain amount of machine-gun or artillery fire. The approach of a tank to its final position preparatory to attack should always, therefore, be covered by a certain amount of shooting.

3. Against infantry or machine guns tanks are almost invulnerable (the Mark IV tank is practically proof against the German armor-piercing bullet) and have great moral effect as well as considerable fire power, but the effect that each tank exercises is purely local. On the other hand, when stationary they form an easy target for the enemy's artillery, though hard to hit effectively when in motion. In addition, they are easily put out of action by a hostile antitank gun.

It follows, therefore, that—

(i) It is essential that the action of the artillery and the employment of tanks should be carefully coordinated. Tanks always draw hostile artillery fire, and counter-battery work is therefore of particular importance.

(ii) An artillery barrage will usually be necessary both to assist tanks in overcoming stationary antitank armament and to cover the advance of the infantry in the usual way.

(iii) Tanks should keep constantly in motion unless they are covered from hostile artillery fire, e. g., by the configuration of the ground or being amongst the enemy's troops.

4. The power of tanks is considerably limited by poor vision, which makes it difficult to recognize objectives or to follow complicated routes. As a general rule, therefore, the most suitable objective for tanks is a clearly defined line of trenches. In any case the objectives assigned should be visible and obvious, and the task simple, definite, and limited.

In detailing tanks to objectives, it should be borne in mind that—

(i) As far as possible, the general direction of their advance should be parallel to that of the infantry. Movements of tanks

diagonal to that of the infantry have been found to draw the latter off their objective or line of advance.

(ii) The best moral effect is obtained, where conditions are suitable, from the employment of large numbers of tanks attacking several objectives simultaneously.

On the other hand, to provide for emergencies, and to replace tanks which from one cause or another have been unable to reach their objective, a proportion of tanks should be kept in reserve.

These conflicting requirements must be carefully balanced according to the circumstances of each case.

(iii) As a general rule, it is useless to give tanks the task of finding objectives, such as detailing a single tank to look for a machine gun which has not been located. If machine guns have been accurately located, tanks are most useful to overcome them.

(iv) The fewer the tanks employed on a given front the easier it will be for the enemy to concentrate his guns on the tanks, and the greater will be the proportion of tanks knocked out. Also, owing to accidents of ground or mechanical trouble, it is not safe to rely on all tanks reaching their objectives. For these reasons it will seldom be advisable to detail less than a section of tanks for any one objective.

(v) Tanks can force their way into almost any objective, but can not halt to hold them in the open, where they are exposed to direct hits by hostile artillery. The position gained must be taken over by the infantry. When this has been done, tanks should move on to another objective or to the rallying point. If the infantry are not able to reach the tanks, it will seldom be any use for the tanks to continue their advance.

5. The frontage to be covered by tanks is governed by the particular situation of objectives and by the facilities of approach. They should not normally work less than 100 yards apart.

Very careful previous reconnaissance is essential in order that tanks should not be deliberately committed to an impracticable route. A plentiful supply of aeroplane photographs must be supplied to the tanks for this purpose.

In addition, the routes to the starting point require very detailed examination in order to insure tanks arriving in time.

6. It should seldom be necessary to employ tanks at the commencement of an offensive to assist the infantry assault on a

hostile front system of trenches which can be adequately dealt with and destroyed by our own artillery bombardment.

As the appearance of tanks will immediately bring down a hostile artillery barrage, they should not usually precede or even start with infantry at the commencement of an attack.

Normally, tanks should wait concealed at first and go out later:

(i) To deal with pockets of the enemy and strong points holding out in the objectives captured.

(ii) To deal with defenses beyond the hostile front system which are interfering with the progress of the battle by holding up the advance of the leading troops.

(iii) When the infantry has reached the farthest objective, and there is sufficient space beyond, to work with infantry patrols and advanced guards and help them to deal with machine guns.

They may also be employed for special tasks, such as—

(iv) Covering the formation of a defensive flank by working outward, so as to provide more room for consolidation.

(v) Flattening sunken or concealed wire which can not be cut by artillery fire. The chances of success are not great and their use for such an abnormal purpose should be rare.

The rôle of tanks stated above will usually entail their passing through the hostile barrage. This can be affected without undue loss, so long as the tanks keep moving.

7. From the foregoing the general principles of the employment of tanks may be summarized as follows:

(i) Each tank formation should be disposed in depth so that if the leading tanks become casualties others can move up to carry out the task.

(ii) The tanks should follow the infantry immediately after the first assault with a view to—

(*a*) Assisting the infantry to mop up pockets of the enemy.

(*b*) To push on to special objectives or carry out suitable tasks which will usually be found in and beyond the second objective of the main infantry attack.

(iii) The tasks and rôle of the tanks should be worked out by the commanders concerned in the same way and in coordination with the artillery program, and each tank attack should be supported by mopping-up parties and sufficient infantry to consolidate and hold the objectives when gained.

8. Both for the reason that a tank draws fire and on account of its liability to lose direction, infantry should not as a rule immediately follow tanks (except for the purpose of passing through wire entanglements), and any tendency to bunch behind the tank should be checked.

From the limited experience available, it would appear at present that the most suitable formation for the infantry to adopt is to follow tanks in small groups in the intervals between the tanks. The advance of the infantry to the objective being controlled in the ordinary manner, independent of any deviation of route taken by the tanks.

9. For purposes of administration, tanks are general headquarters troops, and will be allotted in brigades to armies for certain operations.

The army will allot tanks in brigades or battalions to the corps in accordance with the general plan. The tank units so allotted become, for purposes of the battle, corps troops, and their objectives will be decided by the corps. The details of the movements of tanks to gain these objectives will be worked out in conjunction with the division under whose orders they are placed for the specific operation.

10. The signal arrangements of the heavy branch, machine-gun corps, are not yet completely organized, but are being framed with a view to providing communication between—

The O. C. tank brigade and the army or corps commander.

The O. C. tank battalion and the corps or divisional commander.

The O. C. tank company and the divisional or brigade commander under whose orders he is operating.

The O. C. tank section and the infantry commander on the spot.

The fighting tanks and the forward troops (and by pigeons to the commander of the operations).

NOTES ON MINING.

(From the French.)

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I. GENERAL.

1. As soon as the opposing forces became stationary, mine warfare was inevitable. With the enemy entrenched only a few dozen yards away, the idea naturally occurred that his works might be destroyed from below and that by mining not only could casualties be inflicted, but a very serious moral impression caused.

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At first the operations were very elementary. A single gallery or Russian sap was driven to the point desired, a salient in the enemy's trench, a listening post, etc., so that a charge—it was always a small one—could be laid there.

The enemy soon became aware of our proceedings and was on the alert underground; to our mine attacks he replied by mining.

Thence onward systems of mining and countermining were gradually developed, absorbing a considerable number of men and large quantities of explosives.[1]

2. The attacks are sometimes undertaken only to demolish a portion of a hostile trench, sometimes in view of a local operation; sometimes they form part of a large offensive movement. Generally speaking, the results hitherto obtained have not been proportionate to the efforts expended on them.

There is no reason, however, to conclude that mining should be abandoned. A study of the facts shows that where an underground attack has been properly used it has been of great service, but that when attacks have been without result they have almost invariably been so because they were conducted under unfavorable conditions which from the first made their success doubtful.

Mining is an effective weapon, but it must be applied to suitable objectives and its use restricted by certain rules which have been deduced from experience.

II. GENERAL PRINCIPLES OF THE EMPLOYMENT OF MINING.

3. Prior to this war mining was only thought of in connection with siege warfare. Works which could not be destroyed by gunfire were attacked by mining. The besieged replied by countermining.

But in the underground struggle thus initiated the besieger with superior personnel, material, and explosives at his disposal was bound in the end to win. Each of his successes meant a

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[1] The state of our front lines, which continually suffer from hostile artillery and trench mortar fire, now necessitates greater activity on our part than in the past. The engineers, in almost all the sectors, are completely absorbed in the mining struggle. The number of men already drawn from infantry to assist them is no longer sufficient. (Extract from an order of the German VIII Reserve Corps toward the end of 1915.)

grave setback to the besieged—the loss of an important work or of a valuable piece of ground.

In siege warfare the factors which gave mining its special character were:

(i) The objectives were important and clearly defined.

(ii) Every inch of ground gained was of value.

(iii) The means at the disposal of the besieger insured superiority.

It is otherwise in this war:

(i) The enemy's works do not offer objectives of vital importance.

(ii) The loss of a few yards of ground does not matter; the line can easily be reestablished in rear.

(iii) The two sides have equal resources.

4. Under these conditions, what henceforth will be the rôle of mining? It may be said at once that when the objectives in the zone of possible operations are not sufficiently important to warrant mining operations on a large scale for the sole purpose of destroying them, mining offensives should always be associated with more or less extensive operations above ground.

The objectives will naturally be such points as can not properly be engaged by artillery: Flanking positions on which a sufficiently accurate fire can not be brought to bear; strong points in the enemy's first line which can not be completely destroyed by shells alone, such as villages, areas organized with very deep dugouts, etc.

It is only by careful study of the defensive value of different points in the enemy's line of defense which it is proposed to attack, and of the possibilities of an attack on each of these points, that a decision can be arrived at as to where the employment of mining will be of value.

5. There are, however, other considerations which affect the choice of objectives.

The chances of a successful mining attack vary with:

(*a*) The nature of the ground, which will in varying degrees—

(i) Present difficulties to the construction of galleries (rocky ground or wet soil).

(ii) Favor rapid progress, by the suitability of ground for mining (strata easy to work). Rapidity of execution is, in mining as in every operation of war, one of the elements of success.

(iii) Allow of an attack in force (a considerable depth of suitable ground where galleries can be made at different levels, which is of great value should the enemy be met with).

Underground fighting is not the object aimed at; but if the enemy is met, and this must always be reckoned with, he must be engaged under the most favorable conditions, defeated, and passed.

(iv) Enable progress to be made without attracting the attention of the enemy (ground where it is not easy to listen, or where the work can be carried on at deep levels).

(*b*) The contour of the ground, which will in varying degrees give facilities for—

(i) Gaining a good depth (the conditions are obviously better if the gallery can be started on the side of a hill rather than the side of a valley).

(ii) Removing the spoil and hiding it (the proximity of the mine head to defiladed approaches, woods, etc., is an advantage in this respect).

(*c*) The probability of reaching the objective without attracting the enemy's attention.

It is better not to encounter the enemy en route. If it becomes absolutely necessary to fight him underground, it is quite possible, even though he is worsted, that his opposition may so interfere with our plans as to deprive us of the power to fire the mines when desired.

For this reason, other things being equal, ground where mining has as yet not been carried on is preferable to places where mine fighting is already in progress, and where the enemy, in consequence, is on the alert.[1]

(*d*) The distance which separates the opposing lines.

The difficulties of mining (removal of soil, ventilation, etc.) increase very rapidly as the distance of the working face from the mouth of the shaft lengthens. For this reason the range of attacks has, until this campaign, rarely exceeded 100 to 150 yards.

This limitation of range had few drawbacks in siege warfare. In this war, on the contrary, the production of explosions inside the enemy's lines has a very definite effect. It is there, now that the enemy has reduced the number of troops in his front

[1] See the example of Carency, May, 1915 (par. 49).

line, that the best results will be obtained; and there also the moral effects of the explosion will be greatest.

Although there are attendant difficulties, it is not impossible to attain distances which considerably exceed those which hitherto have been regarded as the maxima.

It must, however, be clearly understood that long tunneling operations should be undertaken only when the objective is of special importance and when the conditions are very favorable.

Lastly, the large amount of personnel and material required for each attack must naturally limit the total number of attacks that can be undertaken.

6. To sum up, the decision as to which parts of the fronts shall be the objectives of mining attacks must be based on the following considerations:

(*a*) Which places in the enemy's lines it is specially important to attack by mining on account of their nature and of the difficulties which would be experienced in attacking them above ground in the ordinary manner.

(*b*) Which of these places (after a technical study of the nature and contour of the ground has been carried out) offers the best chance of success to a mining attack.

7. It is quite evident, of course, that all the conditions considered favorable to mining will only very rarely be present together, and it will therefore be necessary to select those places which combine most, and to exploit these to the fullest extent. As mining is a slow process, it can only be employed in the first phase of a combined offensive for the capture of the enemy's front system.

Nevertheless, where the ground is suitable, bored mines can be used to advantage for the attack of certain parts of the enemy's second positions where the obstacles can not be reached by our artillery fire. Applied by "batteries" on certain parts of the front, they would produce, simultaneously, gaps in the wire entanglements, and defiladed communications by means of which the enemy's position can be reached.

III. ATTACK.

8. *Project of attack.*—The commander, after having indicated the objectives, will order a scheme of attack to be drawn up by the engineer officers who will be in charge of the work. This, when approved by him, will be the working plan.

It is absolutely necessary to have a scheme of attack. Numerous attacks have failed on account of there being no clearly thought-out plan. The commonest mistake (at least in the early days of mining) has been failure to anticipate possible counter-mining by the enemy, and to commence the attack without guarding against it.

9. The project of attack will include—

(i) The plan of the work to be carried out.

(ii) List of personnel, material, and tools required.

(iii) The method of carrying out the work (order of urgency of the work and the allotment of the means available).

It will be based on—

(i) A detailed study of the objective and the ground.

(ii) Knowledge of the properties of the means available (what can be effected with the tools and the power of the explosives).

(iii) A consideration of the principles which govern every operation in war (concentration on the points of attack of all means available which can usefully be employed, the taking of every precaution to insure that the objective will be reached in spite of the resistance of the enemy, etc.).

10. From a study of the objective on the map and from aeroplane photographs, supplemented by actual observation on the ground, the following points can be settled:

(i) The limits of the front to be attacked in order to cooperate in the combined offensive.

(ii) The exact objectives to be attacked.

(iii) The possibility of countermining by the enemy.

From a study of the subsoil (borings being made if necessary) the undermentioned facts can be established:

(i) The limits in depth of the strata in which mining is possible, and in which consequently it is necessary to take precautions. It must be noted that the enemy, when warned, may take the counter-offensive and establish a system of counter-mines, not only against our attacks but also against neighboring portions of our systems which offer suitable objectives within reasonable distance. This has happened on several occasions.

(ii) The strata in which work can be carried on with the greatest rapidity or security.

11. Study of the objective and the ground will, therefore, furnish the information necessary to settle the essential elements of the scheme; that is to say, the preparatory operations of the attack (galleries, branches, etc.), as regards those parts of the objective which it is proposed to destroy.

It must not be overlooked that the enemy may intervene, and the attacks must be arranged so as to reach the objective in spite of anything that he may do. The vulnerable parts are the flanks; that is, both the flanks of galleries or branch galleries which are first made, and also the flanks of the combined scheme.

It will thus be necessary—

(i) To make the scheme so that the galleries, etc., will be close enough together as regards the front (and as regards depth, if the depth available makes it necessary to have galleries on different levels) that the enemy can not get through without being destroyed; or, in other words, to ensure that the whole of the ground suitable for mining is within the radii of the rupture of the mines.

(ii) To cover the flanks by galleries or branch galleries echeloned back.

12. The judicious placing of the different branches, so that they support, without running the risk of damaging each other, must be the subject of a special study based on the knowledge of the effects of underground charges.

Time being of capital importance in a mining attack, especially when the enemy counters, it is necessary, in order to progress steadily and at the maximum pace—

(*a*) To estimate, before starting work, the amount of personnel (engineer units, infantry parties), material, tools, and explosives required.

(*b*) To settle the employment of the available means on a detailed working plan.

EXECUTION OF THE ATTACK.

13. The execution of the attack as regards mining does not present any particular difficulties in suitable ground, as long as the enemy is not met with. If the enemy is not already on the lookout, endeavor must be made to pass without his knowledge, and consequently avoid doing anything which might attract his attention (as hiding of the spoil, making as little noise as possible, etc.).

But it is absolutely indispensable to be always ready to take the offensive if the enemy is encountered.

There must, therefore, from the very first, be an organized lookout service, including:

(i) A watch above ground. If the enemy does not take very careful precautions, it may be possible to recognize from certain

signs (e. g., spoil heaps) that he has commenced mining, and sometimes actually to locate his shafts.

(ii) A watch below ground (listening galleries, etc.). Even if the shafts are at a relatively long distance from the enemy, listening must be arranged from the very first, in order to train good listeners and to accustom them to the particular ground. The maximum distances at which mining can be heard are very variable (from a few yards in ground in which sound travels badly, such as clay, up to 50 yards, and even more, in soil like chalk, where it travels easily).

14. If the enemy tries to bar the way by counter-mining, a breach must be made in his system, so that, in spite of him, the galleries may be driven to their objectives and the charges may be placed in accordance with the scheme.

The underground struggle which will then ensue must aim at clearing the ground by blowing in the enemy's galleries, and at holding him to one part of the front whilst the attack passes elsewhere (to one side, above, or below) by working quicker.

To do this successfully it is necessary:

(i) To get ahead of the enemy and strike before he can strike. This requires an accurate plan of the mines, a well-organized system of information, and decision and rapidity in execution.

(ii) To go for the flanks of the enemy's galleries, which will thus be put out of action for a greater length than if the attack was directed head on; all the more so because the sides of branches and galleries offer less resistance to the explosion.

(iii) To strike as hard as possible. Generally speaking, in the course of an underground struggle there is no advantage in producing effects above ground (craters). Craters, in fact, have the disadvantage of producing an obstacle on the surface over which the attack must move. Camouflets with maximum charges should be used, which will vary with the depth at which they are placed.

(iv) To strike only when within good range. This requires great coolness. Every explosion necessarily causes a temporary delay in the attack, because it will damage part of the gallery leading to the charge. A mine should only be fired when it is considered that it is likely to do more damage to the enemy than to ourselves.

15. On reaching a suitable distance from the objective the mine chambers must be formed. Their number and the charges used will depend on the effect that is to be produced. Results

above ground now being required, common and even overcharged mines will be used.

IV. DEFENSE.

16. The usual measures of precaution employed in ordinary warfare above ground must be taken below ground whenever the distance of the enemy and the nature of the soil do not exclude all possibility of a mining attack. With this in view, it is necessary to have—

(i) A lookout service (observation of enemy's works above ground, listening posts).

(ii) Means of defense (counter-mines).

17. Close observation of the enemy's works above ground will sometimes give useful indications (an abnormal amount of spoil or spoil of a different color to that of the surface strata).[1] It will sometimes even establish the positions of his shafts. Certain characteristic noises (such as the rumbling of trollies) will also indicate tunneling in the area where they are heard.

18. More reliable reports can be obtained by the listeners (engineers or infantrymen) placed in the listening posts at the end of galleries constructed for this purpose. Their duties are to note the underground noises that they hear and to judge their direction and distance.[2]

When the listeners have found indications of the enemy's activity, their observations will be tested and interpreted by officers.

19. The systems of counter-mining are based on the same principles as offensive mining, because they must insure the possibility of counter-attacking with success if the enemy attacks.

They will, however, be pushed out only to such distance as may be necessary to arrest the enemy before he is in a position to reach our lines, and only the portions of the scheme essential for this purpose will be made beforehand. Prudence must be exercised in making them, for they may be interpreted by the enemy as an offensive and thus lead to a mine warfare which is not desired.

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[1] This lookout is one of the duties of the infantry (Instructions of Dec. 4, 1915, on Liaison I.—B.). Add the examination of aeroplane photographs.

[2] Engineer units will not usually be able to provide sufficient listeners. It is, moreover, easy to give the infantryman enough instruction, before mine warfare is commenced, to make use of him as a listener.

If the enemy attacks, the best method of stopping him is to undertake the destruction of his mining system by a resolute counter-offensive. It is only in this manner that decisive blows can be struck at him.

A consistent system of establishing a barrage of mines and waiting till the enemy is at close range before using them may have local and temporary results; but its employment should not be a matter of course. As in the attack, the camouflet will generally be employed. Cases, however, will occur where it may be advantageous to employ heavy charges (common or even overcharged mines) in order to clear the ground on as extended a front as possible. Craters between the two lines of trenches are not open to the objections in defensive which they are in offensive operations.

20. If the enemy's shafts have been located, they should be attacked with artillery and trench mortars. Even if they are not seriously damaged, an appreciable delay in the enemy's working may be anticipated.

Local attacks must also be taken into consideration. The object of these may be either to put an end to mine warfare by gaining possession of the ground where the enemy's operations begin, or simply to attack the entrances of the enemy's shafts with explosives.

In this latter case the importance of the destruction which can be done must not be exaggerated.

APPENDICES.

APPENDIX I.

Arrangement of a Mine System.

21. *Depth.*—The maximum offensive or defensive power is reached when the whole of the ground in which mining is possible is secured. As mining absorbs a large number of men, ingenuity must be exercised to secure this condition with as much economy as possible; that is to say, the development of works which are not likely to be indispensable must be avoided. There may be galleries at one, two, or even three levels, according to the depth of ground that is suitable. At certain points on the front there actually are galleries on three levels.

Rôles of the different parts of the system.

22. The different parts of the system must mutually support each other. The flanks must be guarded.

These conditions have been secured in attacks during the present war by following well-established methods:

(i) Galleries placed at such distances apart as to be mutually supporting. The distance depends on the depth; the greater the depth the greater the radius of rupture that the mines may have. In a system at several levels, galleries on the lower ones will therefore be less numerous than those on the higher levels.

(ii) Galleries at wider intervals, the intervening ground being held by branch galleries off the main galleries or off the cross galleries joining up the latter.

(iii) Protective arrangements for the flanks, made either by branch galleries off the flank main galleries or by special galleries from which branches or borings are driven outward.

23. Although they have incontestable advantages, cross galleries have proved disadvantages—danger of affecting the whole system for quite an appreciable time if successfully damaged by the enemy and great vulnerability when too close to the enemy. It should be laid down, therefore, that there should be cross galleries connecting all parts of the system, but a sufficient margin should be kept between them and the limit of possible action of the enemy's mines.

24. *Mine dugouts.*—Mine dugouts or lodgments, as they are also called, must be made behind the first line, in spite of the extra work entailed. Their establishment in front of the first line—an arrangement, however, rarely met with—has led to disappointing mistakes. Trenches normally in occupation are to be avoided (interference with the movement of troops occupying them and with removal of spoil by working parties). Starting from the front-line trench will be exceptional, and will only occur when it is absolutely necessary to gain ground to the front rapidly (when an enemy attack has nearly arrived within dangerous distance).

25. In the case of an important attack a good arrangement is to establish the mine dugout in an inclined great gallery at sufficient depth to be proof against heavy shells. Large boring machinery could be used for this. Shelter for a portion of the men on duty and the various offices and stores necessary (command post for the officer on duty, with a telephone room; first-aid post; stores for life-saving apparatus and explosives) can be provided there.

26. *Entrance to mines.*—The inconvenience of shafts (difficulties of bringing men and material to the surface, ventilation, the feeling of insecurity which they inspire in the miners) has been definitely reported in the majority of the cases in which this form of entrance has been used. To these disadvantages must be added great vulnerability, particularly in the case where shafts are made within the galleries (winzes or staple pits) in order to gain depth rapidly when quite near the enemy.

Shafts are only a last resource (pis-aller) and should be employed only if conditions make it absolutely necessary to get quickly to a great depth or the ground is sloping toward the enemy, etc. An inclined gallery should always be made afterwards if possible. Depth can always be gained by giving the galleries a steep slope (2/5 and even more has been used).

APPENDIX II.

Execution of the Work.

27. *Documents.*—The opening and keeping up to date of the books, etc., mentioned in "L'Ecole de Mines (Livre de l'Officier)"—mining diary, listening diary, plan of galleries—are obviously as indispensable in trench as in siege warfare, but this has often been lost sight of. It is convenient to use the conventional signs laid down in "L'Ecole de Mines (Livre de l'Officier)," Mining exercises 295.

28. It is important to have as accurate as possible a plan of the galleries (levels, base carefully measured), so as to obtain the best results from the means available and leave as little to chance as can be helped, and to put down with sufficiently accurate approximation what is known of the enemy (results of listening, craters, etc.), in order to be in a position to strike him with certainty. It is also necessary, when a relief occurs, to be in a position to furnish the units which take over with as accurate and detailed information as possible. It is of course necessary to begin by fixing the objective to be reached as accurately as possible. The existing maps are not always sufficiently exact and must be corrected and completed; assistance should be obtained if necessary from the topographical sections.

Organization of Work.

29. The organization of the work has considerable influence on the rapidity and efficiency of its execution. For an operation of any importance careful study is required in order to decide what personnel, tools, material, and explosives are necessary and how to get the fullest value out of them. (Arrangement of the various working parties so that they work in with each other and that no time is lost.)

Here, again, guidance can be obtained from "L'Ecole de Mines (Livre de l'Officier)," particularly as regards—

(i) Organizing the reliefs in such a manner that working parties always return to the same job (gallery, branch, or shaft).

(ii) Organizing the regular supply of tools, materials, and explosives and regulating their transport so as never to be stopped by lack of material or by damage to tools.

(iii) Establishing as soon as possible the various offices and depots required to insure smooth working—command post for the officer (or officers), telephone office, first-aid post, depots of materials and tools, and small depots for explosives.

TYPES AND CONSTRUCTION OF GALLERIES.

30. Experience has proved that our various types of underground communications meet the requirements of the war and that there is no advantage in limiting ourselves, as the Germans do, to a very small number of types.

It is difficult, moreover, to imagine any scheme of attack without some galleries of large section.

It is true, as some officers have noticed, that speed is not gained by decreasing the section below the size of the "small gallery."[1] But the "charging gallery,"[2] which has much more resistance than the larger types and allows of much more rapid tamping, is none the less very useful and effective in the attack.

31. In ground where it is easy to work and difficult to listen, Russian saps have sometimes been used with success. Progress is rapid; ventilation can be obtained or, at any rate, assisted by air holes bored to the surface. In some cases these saps have been lined with ogival frames. On some occasions the roof was blown in by long charges at the same time as the mine was fired, and by this means communication trenches were formed which permitted the enemy's position to be reached under cover.

32. Earth borers have given good results where the ground was sufficiently hard. Cumbrous and noisy, these machines can hardly be employed close to the enemy. It has, however, sometimes been noticed (in the Vosges and Champagne) that the noise of the borer has thoroughly scared the enemy and caused him to fire a number of mines prematurely.

In any case in an important attack earth borers can be very usefully employed to excavate portions of the main galleries at a distance from the enemy.

Bore holes, which have the reputation of being difficult to make and not very effective, have been used with success in a certain number of cases (for listening or placing a camouflet).

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[1] "Demi gallerie."—Width, 1 meter (3 feet 4 inches); height, 1.30 to 1.50 meters (4 feet 3 inches to 4 feet 11 inches).

[2] "Rameau de Combat."—Width, 0.60 to 0.65 meter (23 to 25 inches); height, 0.70 to 0.80 meter (27 to 31 inches).

33. There is no objection to the use of blasting after the mine fighting has begun and when there is no longer any fear of it attracting the enemy's attention; besides, it is difficult to locate where blasting charges are fired.

34. The rapid removal of spoil is of first importance, for this almost always regulates the rate of progress. The ample provision of suitable plant is indispensable when an important attack is undertaken (narrow-gauge tram lines, trollies with noiseless wheels, winches, moving platforms, according to circumstances).

The concealment of the spoil is an equally difficult problem. Sometimes, when there is lack of places which fulfill the necessary conditions (abandoned trenches, quarries, wooded ravines), special trenches must be dug into which to put the excavated earth.

35. Electric lighting and noiseless ventilating apparatus are indispensable for carrying out large mining operations under favorable conditions.

APPENDIX III.

THE UNDERGROUND STRUGGLE.

36. *Lookout for the enemy.*—From the moment work is commenced the nature of the ground must be studied, particularly from the point of view of the detection of underground noises. For this purpose listening schools must be organized, so that listeners may be trained. They will prove most valuable when the enemy is eventually met with.

This measure is recommended in "L'Ecole de Mines," but it is just as well to call attention to it.

The interpretation of the sounds heard by listeners is the business of the officers. The results obtained will be of greater value if the officers possess long mining experience, and have a thorough knowledge of the methods and ruses of the enemy to whom they are opposed.

37. As has been said above, it is not enough to confine the lookout to below ground. Observation of surface works and photographs will sometimes be of assistance in locating the entrances of the enemy's mines. His craters, if he makes any, must be plotted on the plan with great care.

In certain cases (Artois) the Russian saps made by the enemy were accurately located by the vapor which rose in the morn-

ing from the ventilation holes. In Champagne (Bois Sabot) enemy gallery entrances were detected by means of the smoke which escaped by them after an explosion.

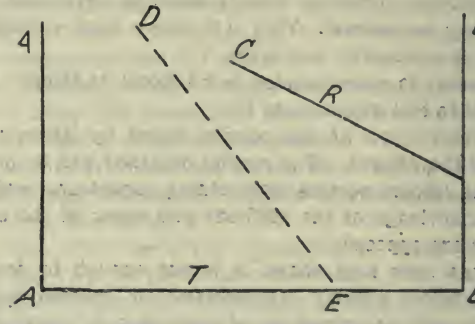
The better the plan of the mines the more certain will be the deductions that can be drawn from scraps of information obtained.

38. *Effects of mines.*—Every engineer officer should know what is stated in the "L'Ecole de Mines (Livre de l'Officier)" as regards the effects of mines. He should make it a rule to note down whenever possible the effects of the service explosives in the particular ground where operations are being carried out.

It should be noticed that the figures given in "L'Ecole de Mines" may possibly be found to be incorrect, especially in relation to the huge charges which are now frequently used.

The special precautions to be taken in firing large mines should not be overlooked. (See the notice of July 19, 1915, on the firing of overcharged mines.)

39. *Destruction of hostile galleries.*—It is always a rule to try and strike the enemy in flank. This can be done either by moving in the right direction, or by drawing on the enemy to expose his flank. If the listeners carefully follow the enemy's movements,[1] there is little danger in allowing him to come quite close. The following is an example: In front of Frise the enemy got between two galleries "A" and "B," joined by a cross gallery "T," passing within range of the head "C" of a branch "R."



[1] "Des écoutes suivies." This phrase conveys the idea that the listeners move as the enemy advances and also keep up continuous listening.—(Translator.)

"C" was charged, listeners in "T" and "B" followed the enemy's work closely. As the enemy was about to reach the cross gallery "E" a camouflet was fired in "C." The wall of the cross gallery was then cut, and the hostile miners who were shut up in the head of their branch by the explosion were made prisoners.

40. Impressed by the inconvenient effects of badly placed camouflets, some officers have thought that it is better to let the enemy fire them than to do so oneself, and that the ideal would be not to fire any, but to entice the enemy to make premature blows. It is in fact easy to conceive that in the presence of an enemy who is not quite sure of himself and a bit demoralized progress can be made, although only a very restricted number of camouflets are fired. In most cases, however, the way must be opened up by force, and to do this one must be able to strike heavily and opportunely.

It will, of course, often be desirable to entice the enemy to explode his charges prematurely or to get him to place mines at points where he will cause only a small amount of damage. For this purpose noise and silence can be made use of, varying them with the circumstances of the moment.

41. In mining warfare it is of first importance to understand the advantages to be derived from knowing when to be noisy and when silent. Generally speaking, it is desirable that the sounds of work should be as imperceptible as possible.

In the clay of Artois, in ground where listening is difficult, numbers of cases have occurred of contact being established, and even the enemy's galleries penetrated without his attention having been attracted. The mining was done with "Sabres Série Z" or sharpened grafting tools; the clay was cut off in small blocks and placed on canvas squares stretched on a light frame;[1] the sappers wore sandals or sandbags on their feet. Analogous results have been obtained in the chalk of Champagne, where sound travels easily, but if precautions are taken blocks can be cut out almost noiselessly.

42. In most ground mining can not be done in absolute silence, but every effort must be made to reduce noise to a minimum (tools that can be used quietly, rigorous discipline, increased precautions as the enemy is approached). For instance, in

[1] "Carrées de toile légèrement tendus." This may also mean squares of canvas lightly stretched by men holding them.—(Translator.)

certain units screws have been used with advantage in place of nails for fixing the frames.

Noise may, however, be made with advantage—

(i) To mask an attack which it is desired to make without the enemy having notice of it.

(ii) To draw the enemy in such a direction that he exposes his flank to our camouflets (by laying a charge in a branch gallery and continuing work at the face of it without any precautions as to noise). The tendency of the enemy to work toward noise, which has often been noted, can thus be exploited.

(iii) To deceive the enemy as to distance and make him believe the heads of our attacks are very near, and thus induce him to fire his mines prematurely.

A pretense of charging can be made so as to induce the enemy to charge in a hurry and to fire before he is within range.

44. If a gallery is in imminent danger of being blown, it should be abandoned after having been shored up so as to reduce the effects of the explosion. Pretense of continuing work should be made by operating a pickax from a distance against the head of the gallery.

45. *Continuation of work after an explosion.*—Work must be restarted as soon as possible after an explosion. To permit this energetic measures must be taken to restore ventilation. Whichever side can recommence attack first after an explosion will have a marked advantage over the other. Deviations should if possible be avoided, as they delay progress. In some cases it may be possible to make a start from the part of the gallery that was tamped and to find the compression chamber, and then ground may be gained rapidly. In others, on the contrary, the amount of ground broken up and affected by a camouflet will constitute an obstacle, and there is no alternative but to work round it.

Knowledge of the nature of the ground in which the work is being carried out will allow of a forecast being made as to whether there is any likelihood of being able to utilize the compression chamber or not.

46. *Unexpected meeting with the enemy.*—As soon as contact is gained measures should always be taken to be in a position to prepare a camouflet quickly; a certain amount of explosives and materials for tamping must be at hand.

To deal with the enemy's galleries, should they be broken into, there should be available—

(i) Means of blocking (chevaux de frise, sandbags lashed together with wire, screens that can be quickly placed and fixed on our side of the breach).

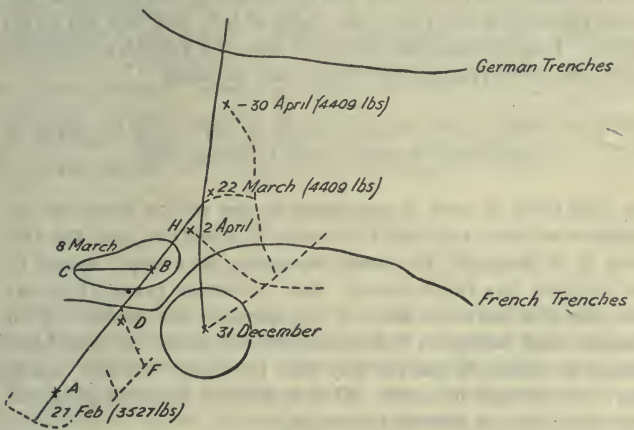
(ii) Daggers and automatic pistols and a small supply of asphyxiating grenades (employed by miners of old and several times used in the course of this war).

DANGER OF ISOLATED ATTACKS; NECESSITY FOR PROTECTION OF THE FLANKS.

47. To make an isolated attack is to invite almost certain failure; this mistake, which occurs very frequently, has invariably met punishment.

The operations at La Pompelle furnish an interesting example. Toward the end of 1914 the Germans ran a gallery at a deep level against the fort of La Pompelle and exploded a very heavily charged mine inside the French lines (Dec. 31, 1914). Distance between opposing trenches, about 150 yards; subsoil, chalk.

The French defensive system, which was at a high level, was of no use. It was at once deepened and developed. The course of these operations (extract from report of Capt. Cussenot) is shown in the following rough sketch:



The enemy, finding himself blocked at "A" on February 27, abandoned "A B" for "B C." While he was working in "B C" the French branch "F D" struck "A B" (depth 82 feet). The captain in charge of the attack with a small detachment en-

tered it, explored this part of the enemy's works without being discovered, and exploded a mine of 1,433 pounds of cheddite at "D" just at the moment that the enemy's miners, attracted by the noise, were attempting to take possession of the charge. The enemy was evidently much shaken by the destruction of his gallery and the asphyxiation of a number of men, for when he returned to work at "B," the head of the part not destroyed, he fired a mine (March 8) which was outside the French line and did no damage whatever.

The enemy's gallery was again cut by French camouflets on March 22 and April 30, after which the enemy abandoned the struggle.

On April 2 the French again penetrated into the enemy's galleries, this time at "H," where the effects of the mine on March 22 could clearly be seen.

The gallery in question had been made by professional miners, not by pioneers; it had no sheeting, only frames made of logs and railway sleepers at about a yard interval. Owing to the absence of sheeting, the effects of our "blows" had been considerable, especially in the upper portions. The enemy had lacked prudence, and judged, owing to the depth of his galleries (65 to 80 feet), that he could work absolutely undisturbed. He took no precautions to guard his right or left, and this led to his undoing. It must be added, however, that the French attack was carried out with remarkable vigor and decision.

MINING IN COOPERATION WITH A GENERAL OFFENSIVE IN SPITE OF THE ENEMY'S RESISTANCE UNDERGROUND.

48. The ideal to seek is obviously to get within range of the objectives without exciting the enemy's attention, and for this reason it is desirable to select objectives in ground where no mine warfare has taken place. But, whatever precautions are taken, one can never be sure of not meeting the enemy. If he is encountered, however, it is not sufficient merely to beat him; he must be beaten in such a way that the final "blows" can be made at the proper moment. This is difficult to accomplish, but it has been done on several occasions.

It is not a question here of small operations which have as their principal object the employment of mines. In such cases the time of attack is subordinated to that of the "blows."

49. In this connection the brilliant mining attacks made before Carency in May, 1915 (report of Lieut. Col. Lebatier), may be quoted.

At Carency mine warfare had begun in the early part of 1915. When a general offensive was decided on, the enemy was very active underground. Six mining companies were opposed to the French. The Germans fired mines almost daily, sometimes several on one day. The French, it may be said, replied to them with interest.

Nevertheless, on May 7, the French had 17 new mines ready, with charges varying from 660 to 3,300 pounds of cheddite. They were blown on May 9, the day of the attack. Their effect was considerable; the wire entanglements were flattened, and the German trenches filled up for lengths varying from 50 to 80 yards. Communication to the rear was cut, and prisoners were made in the isolated portions of the enemy's trenches. Flanking works, armed with machine guns and trench mortars, were destroyed. Flanking fire from works which remained intact and from rifles was rendered valueless by the lips of the craters and by the general upheaval of the ground. At the same time the underground works of the enemy were destroyed. The mine chambers, for the most part charged and fuzed, were smashed, or the mines rendered innocuous by the interruption of the fire arrangements. Numbers of tunnelers were buried in their galleries, others surrendered to the French miners or infantry. Thus the fear of having to cross an area checkered with mines, which affects even the best of soldiers, was dispelled from the minds of the attacking columns.

APPENDIX IV.

Methods of the Germans.

50. The following information has been collected for the most part from reports furnished by engineer officers who have taken part in mining operations. The German methods have naturally developed since the beginning of the war. They have also varied in different sectors, according to the energy of the commander and the standard of efficiency of the personnel. For instance, one German army advocates the employment of camouflets, while another considers they should only be used in exceptional circumstances. This must be borne in mind when studying the information given below.

51. *Methods of attack.*—At Fontenelle (rocky ground) the Germans have employed the following procedure:

(*a*) They pushed several saps to within about 50 yards of our trenches, joined up the heads, so as to form small works, by a cross trench which served as a starting point. At the same time they started galleries from the sapheads.

(*b*) They first made Russian saps for a length sometimes of 80 yards. Manholes stopped up by day were used for watching at night. From the heads of the Russian saps two or more branch galleries were commenced. A system of this kind was found and explored by a French patrol. It was destroyed by a charge of 1,100 pounds of cheddite.

52. At the Croix des Carmes the enemy always tried to extend his attacks at the flanks. He even got so far as to cut the extreme right French branch gallery; but this the French turned to their advantage, as they were able to penetrate into a hostile gallery which led into an abandoned compression chamber.

53. At Eparges "the Germans seem to have been working on the principle of a close system of counter mines comprising several lines of charges." A striking change of tactics was noticed after a little time. Instead of operating with small charges on their most advanced line, as at first, the Germans began to use very large mines. As the depth was increased, so the size of the mines increased.

54. The German pioneer often seems to adopt waiting tactics. He arrives near one of our attacks, prepares a charge there, and then disappears completely for quite a long time without any listening post being able to detect him. He thus allows our real attack to pass him, and when it arrives near enough to menace the gallery which leads to the mine chamber he charges it and blows, thus cutting our attack far in and for a great length.

55. In Champagne (region of Perthes les Hurlus) the Germans had galleries on two levels. While they attracted the attention and efforts of the French to the upper level, which was 30 to 50 feet deep, they constructed deep galleries at 80 feet, which they pushed under the front line.[1] The French got wind of this

[1] This is an application of the method suggested by the German "Instructions for engineer duties in siege warfare" (art. 267). (This has been translated into French under the title of "Instruction sur le Service du Pionnier dans la Guerre de Siege.")

"In such a case (attack of a part of the enemy's position defended by counter mines) it is desirable to push several galleries toward the objective as quickly as possible and without trying to avoid attracting at-

through the particular resonance of the chalk soil of Champagne and were able to evacuate their galleries in time.

56. After the offensive of September-October, 1915, the German system of mines in the Bois Sabot and at Souain was explored:

(*a*) At the Bois Sabot 10 mines, disposed on a salient about 150 yards in length, were pushed out directly from the first line. There were no mine dugouts. The entrances were either by deep shafts (4 by 2 feet 7½ inches) or by inclined galleries (4 by 2 feet 7½ inches), with a very steep slope ($\frac{7}{10}$ to $\frac{8}{10}$), or with an average slope of $\frac{4}{10}$. The mines were connected in pairs by means of cross galleries. They comprised a high-level system, 23 to 26 feet in depth, and a low-level system, 39 to 42 feet deep.

Certain galleries had shafts a good distance in from the mine entrance, placed in branch galleries 3 feet 4 inches by 2 feet 3½ inches. The enemy, no doubt had been anxious about our work, and judging his depth was insufficient had desired to increase it rapidly.

(*b*) At the salient of Souain, 19 branch galleries, arranged in groups, appeared to cover portions of trenches which were of importance, either because of their position or because of works which they included (concrete observation posts, for example).

The greater part of the branches seemed to have been hastily constructed; their walls were irregular. It appeared as if there had been no fixed method of gaining depth. There were mine chambers at the ends of some branch galleries.

(*c*) At the salient B (northeast of St. Hilaire-le-Grand), the system was composed of 11 branch galleries starting from the front line. There were no dugouts at the points of departure. Average slope $\frac{4}{10}$ to $\frac{5}{10}$. Length of branches almost uniform (40–50 yards). Maximum depth was about 65 feet. There were shafts 16 to 20 feet deep at the ends of most of the galleries. The German attack enveloped the French system on both flanks.

57. At Troyon (north of Fismes) the enemy pushed galleries well spaced apart toward our lines (depth 20 to 26 feet, rock

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tention; while other galleries, off which it is intended to lay charges for the decisive action, are dug to follow up the others and form a kind of second attack.

"The first series will induce the enemy to fire his camouflets prematurely, the second will then be pushed forward as quickly as possible, and the mines fired before the enemy has had time to get rid of the foul air, clear his galleries, and put other charges in his counter mines."

underneath). Each infantry company is said to have been responsible for two attacks, under the direction of engineer officers.

The enemy worked intermittently and at different hours, which sometimes made it difficult to interpret the results of listening, but he stuck to the same work for several months. His efforts were, it may be said, often out of proportion to the object in view (for instance, a gallery about 50 yards long, in very hard rock, which must have taken six months of work, proved useless, for the trenches threatened were evacuated in consequence of the noises heard).

It may be noted that the enemy on many occasions, after one of our camouflets had been fired, came back at once to the head of his gallery and fired a camouflet in his turn—this was obviously of no use because of the increase of distance resulting from the first camouflet.

58. At the Bois de la Mine (region of Berry-au-Bac) the enemy camouflaged their spoil dumps very cleverly.

As soon as they were detected they mined only very irregularly, working very quickly without stopping for several hours, then stopping work altogether for one or more days.

The characteristic noises of charging and tamping were masked by continuous blows on the wooden casings of the galleries, along the whole front of attack at the same time, up to the moment of firing

59. In the region of Troyon (north of Fismes) it was observed that the majority of the German camouflets left a trace on the ground. Perhaps this result was aimed at to insure the evacuation of the gases. Even if it is objectionable to betray the presence of galleries, it is an advantage to be able to return to the head without delay.

The enemy sometimes fired two camouflets at a few minutes interval against the same "antennæ."

60. The Germans sometimes placed a small auxiliary mine between their trenches and the principal mine in such a way that when fired it opened a gap on their side in the lip of the main crater and thus facilitated its occupation (observed in Argonne).

61. At Carency, at the beginning of 1915, the German mine entrances were in the front line. The attacks consisted of branch galleries, 3 feet 4 inches by 2 feet 7½ inches, at a steep slope, traced in a straight line. From these the secondary branches started. The system was on a single level, and the

depth of the mine chambers did not exceed about 30 feet. According to notes found in a Mine Diary, only small charges were used (for example, a mine 24 feet deep had only 286 pounds of explosive). This explains to a certain extent the limited action of German mines on the French galleries.

On the other hand the German engineers fired a considerable number of their mines prematurely. The number and certain effect of the French mines must have made them lose presence of mind, which is specially necessary in mining warfare.

Later on, in the same region, the Germans gradually increased the depth of their mines and the charges used.

62. According to reports furnished by a sapper, taken prisoner near Hill 119 (north of Arras), the galleries started from the front line at a gentle slope. The first section served as mine dugouts and shelter for the miners and sappers. At the end of the mine dugouts a deep shaft was made (depth in some cases exceeding 50 feet) from which the real mining attack started.

63. The Germans have often made attempts to damage the French mine entrances by gun or trench mortar fire. Sometimes, but more rarely, they have made local attacks for the same purpose.

In September, 1915, in the sector of Fay (region of Bray-sur-Somme), after a violent bombardment, an attack by a small body of infantry and engineers was launched. The engineers carried eight boxes of fuzed explosives (about 3 feet of safety fuze, detonator with percussion cap). They placed their charges at the entrances of the galleries; only one, however, exploded, and that caused very little damage (the part blown up was repaired in 48 hours). The Germans were driven back into their trenches by a strong counter attack.

64. *Types of galleries and tools.*—The Germans generally use for their branch gallery or shafts the regulation cases (large cases, 4 by 2 feet 7½ inches; small cases, 3 feet 4 inches by 2 feet 1½ inches; both 9.8 inches wide.) (See the German "Sprengvorschrift.")

They often increase the depth as they advance, either by sinking shafts or by inclined galleries at a steep slope, or stepped. They have often made use of Russian saps. In some cases they have worked without lining or with a lining formed of a few planks supported on extemporized frames.

65. Boring machines of large power do not seem to have been in general use by the Germans; it has been definitely stated on certain parts of the front that they are using ordinary miners' tools exclusively. They are believed, however, to have employed electric boring machines in the Vosges and ratchet borers in the Argonne; the latter made listening very difficult. In Argonne they have sometimes employed large earth augers, with cutters about 2 feet long and 8 inches in diameter.[1]

66. The Germans have a handy pattern of silent ventilating apparatus, with which they seem to be well provided. It has sometimes been noticed that they return fairly quickly to the heads of their galleries after an explosion, thanks no doubt to the energetic use of their blowers. It should be noted, however, that certain German instructions recommend that some time should be allowed before restarting work, *vide* Order of VIIIth Reserve Corps, July 17, 1915. "Experience has shown that in limestone soil it is dangerous to enter mine galleries near which there has been an explosion. The danger is not entirely over for several weeks. The greatest prudence must be observed * * *."

In Champagne numerous and very efficient apparatus for breathing in foul air were found in the enemy's mine galleries that were explored after the offensive of September, 1915.

67. The employment of electricity to light the galleries is said to be far from general.

68. It does not seem as if the Germans have any first-class apparatus for removing spoil or water. They often use sacks with handles to carry earth; it is no doubt their trick of frequently altering the direction and inclination of their galleries which has led them to employ this method generally.

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[1] This is a regulation tool. (See "Sprengvorschrift," fig. 231 (*a*).—Translator.

ORDER OF THE SIXTH BAVARIAN DIVISION REGARDING MACHINE GUNS.

MACHINE GUNS.

The Battle of the Somme has again shown the decisive value of machine guns in defense. If they can be kept in a serviceable condition until the enemy's infantry attacks and are then brought up into the firing position in time every attack must fail. The greater the efforts the enemy makes in the future to destroy our trenches before his assault by an increased expenditure of ammunition, the greater the extent to which we must rely on the employment of machine guns for repulsing attacks. These should be brought into action unexpectedly and continue the fight when the greater part of the garrison of the front-line trenches is out of action and the enemy's barrage fire renders it difficult to bring up reinforcements. In view of the above, all improvements to existing works and all new construction must be carried out on the following principles:

1. In regular trench system, the accurate trace of which is known to the enemy by aeroplane photographs, and which he is therefore able to destroy, as regards the greater part, at least, of the foremost trenches, the employment of machine guns is only permissible when they can be kept in serviceable condition in deep dugouts with several exits and when it is possible to bring them into position in time, owing to the existence of strong obstacles which can not be completely destroyed by bombardment, or to the possibility of close observation of the enemy's movements.

The first trench and the ground between it and the second trench are therefore quite out of the question, for even if they contain excellent dugouts, there is no certainty that the enemy's assault can be seen in time. Machine guns should therefore be placed, as a rule, behind the second or, better still, behind the third trench. The methodical fire by which the enemy seeks to destroy our trenches is considerably less effective here, and, further, the obstacles erected in front of the second and third

trenches and around the machine-gun emplacements themselves make it possible to see the enemy's assault in time. Commanding positions with a very wide field of fire or positions which can at least flank the trench system should be selected. About half the machine guns should be allotted to such positions.

2. The remainder should be sited behind the trench system and on ground farther in rear, in deep pits which are usually covered over and also on platforms concealed in trees, in such a manner that the enemy is caught in an unexpected cross-fire if he breaks through. The important point is that the machine guns should not, in any circumstances, be detected beforehand. They must not, therefore, be too close to trenches which can be photographed or to well-defined woods which the enemy will suspect in any case. The best sites are in the open, in or under clumps of trees and bushes, or in hedges. All the earth excavated must be removed or concealed under hedges, etc. A low network of trip wires has proved to be the best form of obstacle. To each machine gun there should be allotted a certain number of infantrymen armed with hand grenades, who can also work the gun if necessary.

3. The construction of special machine-gun emplacements is not advisable. If sited in the position itself they are destroyed and if farther in rear they disclose their positions. The guns should either be fired from improvised mountings or from sandbags.

4. In cases where the ground which the enemy's attack has to cross is not covered by machine guns sited in retired positions it is necessary to hold machine guns in readiness even in the first trench, particularly by night or during misty weather, as a means of defense against surprise attacks made without artillery preparation, though these can only be of local and minor importance. The machine guns mentioned in paragraph 2 should be employed for this purpose. By day, however, or at the very latest as soon as intense artillery fire begins, they should be taken back to their proper positions.

5. Machine guns may always be sited in the front trench in thick woods or under other exceptional conditions. The decision in such cases will rest with me; suggestions should be submitted.

(Signed) v Hoehn.

METHODS OF ATTACK OF THE GERMAN INFANTRY.

In all the general actions which took place in the neighborhood of Verdun between February 21 and April 15 the German corps attacked with their divisions side by side. In exceptional cases, when the extent or importance of the zone of action allotted to a corps only allowed of the engagement of a single division, the other division remained resting behind ready to relieve the division in the front line.

I. Zone of Action and Dispositions of the Division.

The extent of the zone of action of a division of three regiments (7,200 rifles) varied from 1,000 to 2,500 meters, according to the importance and number of the successive objectives, e. g.—

(1) On April 11 the twenty-first division, starting on a front of about 1,000 meters (Douaumont Fort (exclusive) to the southern branch of the Fausse Côte Ravine), was required to attack in the general direction of Verdun.

Its zone of action had an average width of 800 to 1,000 meters, the successive objectives being Bois de la Caillette, Fleury-devant-Douaumont, Fort St. Michel.

(2) On March 6 the twenty-second reserve division started on a front of about 2,500 meters from Forges Brook (500 meters in front of Forges) to the Meuse.

Its zone of action had an average width of 2,000 to 3,000 meters, the objective being the line Bois des Corbeaux-Bois de Cumières-Point 265 (east of the Bois de Cumières).

(1) Is an example of an action with a distant objective (narrow zone of action, successive objectives).

In this case the twenty-first division had two regiments side by side in the front line with one in reserve.

(2) Is an example of an action with a limited objective (wide zone of action, a single objective). In this case the twenty-second reserve division had its three regiments side by side in the front line.

In both cases the density of the frontage of attack was almost the same, the front of a regiment varying from 500 to 800 meters.

II. Dispositions of the Regiment for the Attack.

Whatever the disposition of the division might be, the regiment was generally disposed in depth in successive battalions: One battalion in the front line, two battalions in the reserve, echeloned in depth at distances varying with the nature of the ground, the nearest battalion being ready to move up either to support the attack on the first objective or to undertake a fresh attack beyond that objective, the farthest battalion often resting, and in such cases destined for the relief of exhausted units.

III. Dispositions for and Method of Attack by the Battalion.

DISPOSITIONS.

The infantry battalion was nearly always deployed in two lines.

The first line was generally composed of two companies side by side, which deployed either in the departure trench or in the last cover from which the assault was to be launched.

The second line remained in the support trench in shelters or behind cover.

METHOD OF ASSAULT—WAVES. GENERAL PRINCIPLES.

(1) Each attacking line was always given a definite and limited objective (its width being equal to the front of attack and its depth seldom exceeding that of two successive lines of trenches).

(2) The assault was not launched until the artillery had completely wrecked the trenches, destroyed the obstacles, and rendered the defenders incapable of resistance.

(3) The actual assault was preceded by reconnaissances pushed forward toward the objective with a view to ascertaining whether the artillery had achieved the desired effect. These reconnaissances in reality formed the first wave of the assault.

It appears that the other waves did not start unless the first made progress. What has often been regarded as an ordinary reconnaissance intended as a feeler against our lines has in reality been the beginning of an attack nipped in the bud.

EXECUTION OF THE ASSAULT.

The attacking line debouched in several successive waves. The various methods noticed resembled more or less the following type:

Three successive waves at 20 or 30 paces distance.

First wave (reconnaissances).—One or two squads from each platoon, accompanied by some pioneers and bombers, in skirmishing order and at very wide intervals.

Second wave.—A dense line of skirmishers composed of the main body of each platoon. This line seized the trenches.

Third wave.—Composed of the remainder of each platoon and forming an echelon which filled up gaps and carried a reserve of ammunition and material (tools, sandbags, etc.) in order that the captured trenches might be converted.

RÔLE OF THE SECOND ATTACKING LINE.

This line was, in principle, reserved for a second assault beyond the objective captured by the first line. In exceptional circumstances it might be employed to reenforce the first line or rally the latter in case of failure.

NOTE.—The assaulting waves were always deployed. Prisoners were unanimous in stating that they have never seen the employment of columns in the assault. It may so happen, however, that the two waves, debouching in dense lines, may sometimes have had a number of stragglers behind them, thus giving the impression of small columns following the first waves.

PRACTICE ATTACK CARRIED OUT BY THE SECOND BATTALION, TWO HUNDRED AND EIGHTH RESERVE REGIMENT (XXII RESERVE CORPS).

This battalion recently carried out the following exercise whilst at rest behind the front line.

The company formed three, four, or even five waves, which all left the trench in skirmishing order.

The object of the first wave was to cross the first French trench and to push forward to within bombing distance of the second trench. There the men lay low, threw their grenades, and leapt into the trench as soon as these exploded.

Each man carried six grenades and a small pair of wire cutters.

The object of the second wave was to reach the first French trench. It acted in the same way as the preceding wave, starting as soon as the latter had crossed this trench.

The third wave carried tools, shovels, picks, large wire cutters, and portable obstacles.

The fourth wave carried tools and rations.

The attack was launched at a fixed hour, watches were set, and the waves were started by means of whistle blasts.

The men were told off by name to the different waves.

THE CONSTRUCTION OF FIELD DEFENSES.[1]

The varied conditions under which defensive positions have to be prepared (before or during a battle, in the course of an advance or a retreat, etc.) prevent definite rules for their construction being laid down. It is only possible to establish the general principles underlying it.

1. A stubborn defense, organized by sectors, must be absolutely assured. This calls for several successive positions—at least two—and, in addition, in order to prevent the enemy from extending after the partial capture of the front-line position, the provision of switch lines from which the enemy can be taken in flank.

2. The distance between positions must be sufficient to exclude the possibility of the rearward position being attacked simultaneously with the one in front. Each successive position must entail a completely fresh attack, and above all oblige the enemy to push forward his observation posts and at least a portion of his batteries. Depending on the ground, this distance will, therefore, be from 1 to 2 or more kilometers.

3. Each position will consist of at least two continuous lines, one behind the other. As a rule, the front line will be the main fighting line. This principle may only be deliberately abandoned when the first line is unfavorably situated. Support lines ought not to lie within the zone of artillery fire directed on the front line. On the other hand, their distance from the front line must not be too great, as this might prevent a rapid advance from the support line to repel an assault, to counter attack, etc., it will thus vary between 50 and 100 meters. (See also par. 8, "Communication trenches.")

4. A field of fire of a few hundred meters, or even less in certain circumstances, is sufficient for the front lines of an infantry position. The greater the extent of our own field of fire and the more extended the view from our own position, the easier it will be for the enemy to observe and carry out counter battery work.

[1] Issued by general staff (intelligence), general headquarters, October 16, 1916.

On the other hand, a very limited view from the position necessitates an increased state of preparedness for attack, which in time will wear down the troops. It is of still greater importance that support lines, in which further resistance may be offered after the loss of the front lines, should be screened from hostile reconnaissance and observation, and consequently from artillery fire. They will therefore be traced, in certain circumstances, along reverse slopes, through woods, etc.

5. The entire circumference of natural strong points (villages, farms, small woods) will be organized for defense and exceptionally strongly fortified. Where no such points exist closed works will be constructed as required. Strong points and closed works may be sited with advantage either within a position or between two positions and formed by organizing sections of the front and support line and their corresponding communication trenches as redoubts, capable of all-round defense.

6. Reliable obstacles will be erected in front of all lines of defense, switch lines, strong points, and closed works. As they will be very heavily bombarded by artillery and trench mortars, it is advisable to construct them in several rows with intervals. Electrified wire entanglements are only of value as long as they are not exposed to heavy fire. In quiet times they permit of the garrison being reduced with safety. Where electrified entanglements are used precautions must be taken for the safety of our own troops.

7. Skillfully traced communication trenches must be liberally provided to connect the various lines of each position. They considerably facilitate the execution of counter attacks, and when it is otherwise tactically feasible, they enable a large part of the garrison to be kept in the support and reserve trenches. This diminishes casualties and spares the troops.

In addition, there must be a sufficient number of approach trenches leading up to the position, if sufficient cover is not provided by the form of the ground. When constructing communication and approach trenches they must be organized according to requirements, to serve at the same time either as switch lines or as the flanks of closed works.

8. Deep and narrow trenches afford good cover but circulation in them is difficult and they soon fall in. A certain ratio must, therefore, be observed between depth and width. High parapets are to be avoided if possible, as they are very visable, are

easily destroyed, and then fill up the trenches. As a general rule, as a protection against enfilade fire, infantry trenches should be well traversed, while a zigzag trace should be given to communication and approach trenches.

9. Shellproof dugouts (mined and concreted) have proved of great value. Their occupants, when not overcrowded, have lived through repeated bombardments of long duration and of the greatest intensity. It is advisable to construct numbers of small dugouts (for 20 men at the most), each provided with several convenient and safe entrances. In the main fighting line, or close behind it, a garrison capable of repelling a surprise attack must be accommodated in shellproof dugouts, the rest of the garrison being in similar dugouts in the support and reserve lines of the position. Previous to operations of our own, in which large masses of troops will be employed, a sufficient number of shellproof dugouts must be constructed in the front-line trenches. It is essential to provide underground shelters for troops held in reserve close behind the infantry position, in order to protect them as long as possible from the fire of the enemy's artillery.

10. With a view to the rapid detection of a hostile attack, observation of the enemy's position, both from the front and support lines, even under the heaviest fire, must always be possible. In the front line the most suitable means of observation are periscopes passing through the roofs of the dugouts. Observations from loopholes is certainly preferable, but since it is hardly possible to hide them, most of the loopholes in the front line will be destroyed or buried by the enemy's fire.

Similarly, infantry sentries posted without shelter in the front line will soon be put out of action, and do not therefore insure timely warning of a hostile attack.

In the second-line position observation will be mainly carried out through loopholes. Observation posts must be hidden and made as shellproof as possible.

11. Frontal infantry fire to repel an assault will be delivered over the parapet from rifles, machine guns, and automatic rifles.

When the distance to the enemy's position is very small, before allotting machine guns to the front line for frontal fire it must be considered whether they can be brought into action with sufficient rapidity; if not, they must be posted farther in rear, and, whenever possible, in commanding positions.

12. After frontal fire the chief consideration is flanking fire. The latter enables an extended front to be defended with a minimum of effectives. It may be brought to bear from the position itself, the trace of which should be suitably broken, or from flanking positions, situated to a flank and slightly retired.

Automatic rifles and machine guns are particularly suitable for this work.

Flanking fire from a position to a flank and slightly retired (from the second line or from special flanking positions) presents the advantage that the emplacements are not so liable to be out of action by the enemy's fire. In positions with a good command, in certain circumstances concrete emplacements with suitably masked loopholes can be constructed and will be of great utility.

Light quick-fire guns are also suitable weapons for flanking fire.

13. Infantry positions must be selected, wherever conditions permit, with an eye to the deployment of artillery. The artillery require—

(*a*) Suitable positions for main observation posts.

Observation posts must be covered by the infantry positions, and, whenever feasible, must be sited so far back that they are not exposed to fire directed on the infantry lines. In addition, they should afford a view of the whole of the ground in front of the infantry position.

(*b*) Concealed battery positions at a suitable distance—i. e., a distance at which the artillery can carry out its task—from the enemy. The long range of our guns should not lead to their being kept as far in rear as possible. The length of the telephone lines entailed by this is a reason for avoiding it. On the other hand, batteries should not be placed in positions which are in the zone of artillery fire directed against the infantry.

(*c*) Cover that blends with the landscape, in particular, shell-proof shelters for both the personnel and the ammunition.

Suitable arrangements, in accordance with the above, will be made for the artillery reserves, when these are engaged.

14. To enable commanders to exercise their command, even during a hostile attack, the battle headquarters of sector (regimental) and subsector (battalion) commanders will be shell proof and situated sufficiently far forward and so sited that the commanders concerned can maintain constant communication,

even by means of runners, with each other and with the most advanced points of the fire line. They should thus be in a position to throw in their reserves at will at decisive points. Touch between commanders and their troops and their personal influence on the fight must be insured in all circumstances. It is most desirable that battle headquarters should command a view of the battle sector concerned and of the surrounding country. (See par. 10.)

The same remark applies to the battle headquarters of the higher commanders. Where this is out of the question, owing to the nature of the ground or on account of the zone swept by the enemy's artillery fire, a sufficient number of observation officers from the staff concerned will be pushed forward to suitable points. Communication with these officers and with other important observation posts must be insured.

15. Reliable transmission of information from the front to the higher commanders and vice versa is of special value and requires most careful organization.

Large numbers of telephone lines are required; nevertheless they can not be counted upon during a heavy bombardment. Other means of communication (light-signal apparatus, other methods of signaling, carrier pigeons) must therefore be always available and their efficiency frequently tested.

Sound signals (gongs, bells, sirens, etc.) have proved very useful for alarming garrisons.

16. Speaking generally, the improvement of conditions of living among the troops should be considered in the organization of defensive positions. This includes hutting, water supply, the improvement and construction of roads, bridging, and cutting tracks. Of especial urgency is the development of a field and light railway system for bringing up ammunition, supplies (dumps in second or third line, if required), building material, etc.

17. Positions will be constructed in accordance with definite working plans drafted after careful reconnaissance.

The rainy season will be taken into consideration in both the construction and the improvement of positions; for example, an approach trench will not be taken along the bottom of a depression but along the side. Drainage arrangements must be completed during the dry season.

18. The maintenance of extended positions requires a considerable amount of labor. In the case of retired lines and po-

sitions, owing to a scarcity of labor, the construction of the main framework must frequently suffice; that is to say, the construction of dugouts, obstacles, observation posts, flanking positions, ammunition stores, drainage system, etc. Fire trenches and communication trenches will be marked out, but their execution either entirely or partially postponed. The maintenance of such positions must be taken in hand periodically unless completion is to be abandoned.

INSTRUCTIONS FOR MINE WARFARE.

TACTICS.

1. Objects of Mine Warfare.

Attack.—To drive galleries under the enemy's works in order to destroy them and their garrisons.

Defense.—To drive galleries to intercept those of the enemy and to destroy them at such a distance from the defender's works that the latter are not damaged when the mines are sprung.

Mine warfare commences when the attack and defense meet underground. Every mine sprung, including his own, blows the miner back; therefore after fighting has begun the defender is forced to engage in active mining. The limit of length of galleries driven by hand is 100 meters;[1] beyond this machines must be employed; neither we nor the enemy have yet got a satisfactory machine.

Mining is slow and exhausting work; this means of warfare should therefore be regarded as a last resource by which to capture a position.

A defensive system should be made round every point of tactical value for flanking fire or observation situated within 100 yards of the enemy. When the opposing lines are very close the defensive systems of both sides meet underground. Active mine warfare then ensues.

2. The Principles of Mining Schemes.

Offensive.—The plan of attack must provide for the destruction of the enemy's position at several points simultaneously on a broad front and assist in the isolation and capture of his troops.

The infantry position must first be advanced by sapping as close to the enemy as possible. If opposition is expected, several shafts must be sunk, which must be connected by a lateral

gallery, from which the offensive galleries will start. These galleries must be deep enough to pass under the defense. It is sometimes best to advance on two levels, engaging the defender's attention on the upper level while the galleries on the lower level are driven at the greatest possible speed.

Defensive.—The galleries must be driven straight toward the enemy, at such a distance apart that a maximum camouflet from one gallery will not destroy the next one to it. If the enemy is also mining, the distance apart must be such that he can not pass between any two without being heard; this distance varies with the ground, and is from 20 to 40 meters.

The galleries must be pushed forward until their faces are at least 30 meters from the front trench.

When these are completed, or as soon as there are men available, a lateral gallery must be made connecting the main galleries at such a depth (6 to 10 meters) as will render it safe from heavy high-angle fire and not so far forward that it is liable to be destroyed by mines of either side (about 20 meters in front of the front trenches and 30 meters from the headings of the galleries).

As soon as the defender is aware of the enemy's approach on the deep level, he must follow his example, and this process may be continued until the permanent water level is reached or the depth of the galleries is prohibitive.

The attack can also be countered by an outflanking movement.

3. Mines.

The object of the attacker being to destroy the enemy's works and personnel, this can be done either by firing simultaneously as many mines as possible on a broad front, or by firing a number of overcharged mines at intervals of half an hour, so as to form large craters and to overwhelm the garrison with stones, débris, etc. The formation of craters enables the attacker to advance his position. Camouflets should be used to destroy the defender's galleries. The defender, on the other hand, will avoid making craters which interfere with his field of fire, and will destroy the attacker's galleries by blowing them in from a flank by camouflets.[1]

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1 This is not borne out by the enemy's mining on our front; his galleries have often been of much greater length.—(G. S. I.)

The defender should always have a number of galleries ready charged.

4. Cooperation of Various Arms.

The enemy's mining operations can be sensibly delayed by keeping his mine heads and trenches leading to them under artillery, trench mortar, rifle, and machine-gun fire, with special reference to flanking and enfilading.

The cooperation of all arms is of special importance when it is decided to form craters.

Immediately the mine has been fired, the artillery will open on the enemy's position. The effect of this will be greater if it has been possible to induce the enemy to man that portion of his line in greater strength, by driving the men inwards by trench mortar fire, or by any ruse to make him suspect an attack in force. The danger area of the attacker's trenches will be cleared of troops, and the garrison will take shelter in their dugouts. If the enemy fires a mine, the garrison of the sector will "stand to" in their dugouts, but will not man the parapet.

The occupation of craters, which are blown under the enemy's front line, may form either (1) a local enterprise or (2) a part of a general attack on a broad front.

As regards (1), the mine may be of assistance when the object of the enterprise is to destroy shaft heads, ammunition stores, machine guns, or trench mortars, or to secure identifications, but otherwise the concentration of the enemy's fire on the small section of the front captured renders its occupation and organization too costly to be of value.

Craters made for the purpose of advancing the attacker's position must not be occupied on the far side until the position is secured underground by pushing forward galleries to cover it. A proper system of backing-up galleries should be arranged before the crater is blown. The organization of the interior of a crater is a difficult operation, especially the construction of a parados, owing to the crater being a good target for artillery and trench mortars, by which the defender will endeavor to prevent the attacker from organizing the craters or forming up for an assault. To do this effectively, the defender must have observation of the craters; consequently he must sap out and establish listening posts on them; permanent sentries are not necessary. The obstacle formed by the crater should be improved by knife rests and rolls of wire.

As the cratered area increases, the importance of protection by flanking and machine-gun fire increases in proportion.

5. Chain of Responsibility.

The divisional commander lays down general instructions for mine warfare and is responsible for the cooperation of artillery, engineers, and infantry.

His engineer commander is responsible for the initiation of suitable offensive or defensive mining schemes and for the preparation of estimates of time and labor.

The divisional commander decides (1) whether the positions to be gained are in proportion to the effort required, (2) whether to become involved in mine warfare, or (3) to abandon voluntarily his position as soon as the enemy's galleries are under his trenches.

In either case he submits his decision for approval of the corps.

When the mining schemes have been finally approved, the divisional commander issues the necessary orders to the regimental commanders of the artillery and infantry concerned, and allots to infantry regiments the requisite engineers and trench mortars (complete units, if possible).

The senior engineer officer in each infantry regiment is the commanding officer of all engineers attached to the regiment and of the permanently attached working parties from infantry or labor battalions.

The regimental commander, on the advice of the senior engineer officer, issues orders to the latter and to battalion commanders, who control the trench mortars in their subsectors. He also arranges direct for artillery support from the artillery formation in his sector.

Each mine system is in the charge of an engineer officer, under the orders of the senior engineer officer of the regiment.

This officer can spring mines on his own authority, in cases of emergency.

He must be in the closest touch with battalion and company commanders, and all information regarding the mine system or inferences drawn from observation on the surface will be mutually exchanged. Battalion and company commanders have no authority over the engineer officer, except that they may order him to spring such mines as have been prepared to repel an assault. (End of translation.)

NOTES BY GENERAL STAFF (INTELLIGENCE).

1. The general principles enunciated are not different from our own, but since this article was written the enemy's limit of length of galleries has been greatly increased.

2. Our experience is that these principles have been followed fairly closely, especially the attack on two levels.

3. The enemy has frequently made craters for the sole purpose of improving defilade flanking fire or advancing his position.

4. The description of the rôle of artillery and trench mortars for delaying enemy mining activity, and in conjunction with firing mines, is important.

The enemy's opinion about the value of craters has changed considerably since this note was written. His persistent and successful holding of craters is very marked.

5. Prominence is again given to trench-mortar fire in the allotment of troops for a mining scheme.

THE PRINCIPLES OF TRENCH WARFARE, AS LAID DOWN IN THE FOURTEENTH RESERVE CORPS.

Note by General Staff (Intelligence), General Headquarters.—These are the "Corps orders" referred to in "Lessons drawn from the Battle of the Somme by Stein's Group." (Ia/20767).

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THE PRINCIPLES OF TRENCH WARFARE.

The principles laid down in the XIV Reserve Corps for the conduct of trench warfare are once more set forth in concise form in the following pages:

I. Infantry Positions.

1. *Trenches.*—All trenches must be designed to allow of their use as fire trenches. Communication trenches must permit of fire to both sides. Except in the case of sentries, every man must, as a rule, use his rifle over the parapet.

It must be possible to climb out of every trench, either by means of ladders or sortie steps. This is particularly important for communication trenches, which otherwise become traps.

2. *First-line position.*—The first-line position will be held if the enemy attacks. It must, therefore, be repaired immediately before any other work is undertaken. It consists of the first, second, and third trenches, and should have, if possible, two rows of wire entanglements in front of each trench. There should be at least two communication trenches in each company sector from the third trench to the first trench, but the points at which they enter and leave the second trench should not be opposite one another. The number of dugouts should be increased until there are sufficient to accommodate the infantry garrison that the division considers necessary for the repulse of a prepared attack. Accommodation should be provided, first of all, for the present garrison and supports in the first trench, and for the present sector reserves in the second and third trenches. Further construction may then be taken in hand.

Each battalion sector must have at least two through communication trenches. When fighting is in progress, it may be advisable to use one for up and the other for down traffic. The men must know this beforehand.

Each company will mark its front-line trench with a red and white screen or board about 20 inches square, painted some inconspicuous color on the side toward the enemy. This will be set up on the parapet, or the parados, in such a position that the enemy can not see it either from in front or from the flanks. By this means the artillery can locate our front.

It has repeatedly happened that important letters and sketches have fallen into the hands of the French and English. The troops will be warned of the grave nature of the offense caused by such negligence. Letters must not contain matter of military importance. The number of documents of military importance taken into the first-line position must be restricted as much as possible. An officer is responsible for any document which he carries on his person.

As soon as a document has served its purpose—information to the troops, etc.—it will either be destroyed or taken away from the first-line position. Maps which show the position of trenches may be taken into the first-line position only when our own trenches are merely approximately shown. It is forbidden to take maps into the first-line position which show in detail both our own and the enemy's trenches. Patrols will carry no papers and wear no badges by which they can be identified.

Rations, water, and illuminating materials sufficient for at least three days will be stored in the dugouts of the first trench of the first-line position. The rations will consist of iron rations, coffee, salt, sugar, rum or an equivalent, and cigars. The water supply, to which particular attention will be paid, will be made up of water in barrels and mineral water. Lighting will be assured by means of an iron ration of candles sufficient for three days. In addition, electric light, paraffin, acetylene, or candle lamps may be used.

3. *Intermediate and second-line positions.*—The intermediate and second-line positions each consist of at least two trenches, each provided with two rows of wire entanglements, which should be on pickets, and with the same number of communication trenches as in the first-line position. Each of the present regimental sectors must be provided with sufficient accommodation for at least one battalion.

There must be emplacements in all three positions for machine guns and Minenwerfer and artillery and infantry observation posts.

4. *Third-line position.*—In the third-line position, which is dug only to the depth of a spade blade, strong points will be constructed when instruction in entrenching is being given and when recruits are being trained.

5. *Responsibility for construction.*—Regimental commanders will direct the construction of the first-line position; divisions will be responsible for that of the second-line position, and will make their own arrangements with regard to the intermediate position.

6. *Dugouts.*—The construction of dugouts and observation posts in the first trench of the intermediate and second-line positions will take precedence of work on the second trench of these positions. In view of the heavy guns which the enemy is employing, the thickness of earth above dugouts should be increased for any new ones that are constructed. It may be as much as 19½ feet, depending on the nature of the soil, but the depth below ground must not prevent a quick response to an alarm. All dugouts must have at least two entrances. To close the passage between the entrances stultifies the object of having two entrances. Divisions must direct special attention to this point. Dugouts should be constructed under the parapet, not underneath the parados, and the entrances should be in the front slope of the trench.

7. *Revetment and drainage.*—Revetment and drainage are essential. Revetting a trench with wire netting and corrugated-iron sheeting is forbidden; fascines, also, are not suitable, as they form impassable obstacles if the revetment is destroyed. On the other hand, brushwood well secured by pickets and pegged into the sides of the trench may be employed. The pioneer commander of the XIV Reserve Corps will send up as much brushwood and thin pickets as he possibly can, in accordance with the requirements of divisions.

In arranging drainage, only technically qualified personnel should be employed, as the form of the ground, nature of the soil, surface and subsurface water conditions must be taken into account.

8. *Wire entanglements.*—In the wire entanglements of the second-line position, passages which are clearly marked, easily closed, and not too wide, must be left for the use of troops advancing and retiring. The points where roads traverse the trenches must be left open, but be easy to close.

9. *Concrete.*—The greater distance of the second-line position from the enemy will permit of a more extended use of concrete.

On principle, observation posts and important machine-gun emplacements will be built of concrete.

10. *Villages.*—Villages in the intermediate and second-line positions will be fortified so as to permit of their defense in sectors. During a battle, however, they will not be packed with troops scattered about in cellars and dugouts.

Any conspicuous excavated earth will be disguised.

II. Alarm.

11. *Alarm.*—Conditions vary so much on the extended front held by the XIV Reserve Corps that I refrain from issuing a general order dealing with alarms which would hold good for all the divisions. Divisions will issue orders individually and the corps will undertake the printing of them. These orders will be posted up in all dugouts, even those temporarily unoccupied.

It will generally be advisable to distinguish between an "ordinary alarm" and a "gas alarm," as in each case the procedure differs. It is recommended that the signal for an ordinary alarm should be given by mouth (shout, policeman's whistle, foghorn, etc.), and for a gas alarm by hand (ploughshare, motor horn, etc.). Orders for alarms will be submitted to me.

III. The Infantry Combat.

12. *Sentries.*—Our entire system of defense depends on the trustworthiness of the sentries in advanced listening posts and in the fire trenches. Sentries must, in most cases, remain in the listening posts even during a heavy bombardment. The sentries in the fire trenches must clearly understand that on a dark night they must not rely on the sentries in the listening posts or on patrols sent out in front. Every sentry must be convinced that the safety of the position and of his comrades depends on *his* vigilance and *his* endurance. His task will present great difficulties under an intense bombardment, when he will frequently be forced to take cover. With regard to the latter point, he must be given definite instructions as to whether he should stand at the entrance to the dugout, whether he should lie down, etc. In no circumstances may observation of the front suffer interruption. There will nevertheless be casualties among the sentries. For this reason the garrisons of the

trenches concerned must be in a state of instant readiness in the dugouts, and the commander will immediately replace any sentry who falls. Sentries will carry the gas mask hung on the chest or in the box, with the slings of the mask and of the box around the neck.

13. *Garrison of the trenches.*—The garrison of the first trench of the first-line position should be strong enough to repulse the enemy's attack, assuming that the men reach the parapet in time, but no stronger. The better the first trench is defended by flanking fire, especially that of machine guns, the more can the infantry garrison be reduced. To man the parapet promptly requires constant observation, good alarm arrangements, suitable construction of the entrances to the dugouts, practice of the alarm in the form of a regular drill, and, most important of all, observation of the fall of the enemy's artillery fire (lift of barrage).

Above all, every group commander and every man must realize that the success or failure of an assault depends on his timely appearance at the parapet. It must be made clear to the men that, once in the trench, the enemy will throw hand grenades into the dugouts. Everything depends, therefore, even when the alarm signal is not heard, on not missing the instant at which the enemy's fire lifts, and immediately hurrying to the fire line. Experience has justified the practice of posting sentries, armed with hand grenades, at the entrances to the dugouts, to deny approach to the enemy and to facilitate the task of ejecting him.

Machine guns which are left in breastworks or trenches during the enemy's intense bombardment will be destroyed unless they are covered by very strong concrete emplacements. It will generally be impossible to erect such concrete structures in the first trench. Machine guns must, as a rule, be kept in the dugouts of their crews until the enemy assaults, and must then be placed rapidly in position at suitable points on the parapet without making use of the sledges, as these are too heavy for trench warfare. It is taken for granted that the crews are trained in fire without the sledge, on a pedestal built up of sand bags. This method of fire must be learned. The resulting dispersion, which is known to be the disadvantage of this method, is of no account at assaulting distance.

In order to make the enemy disperse his fire and prevent him locating the positions really employed for flanking fire, the latter must be masked and a number of dummy positions constructed.

14. *Supports.*—The second trench of the first-line position is garrisoned by the supports, one portion of which is specially detailed to defend the trench itself and in particular the entrances to communication trenches, while the other portion consists of strong, specially formed bombing parties, which are held in readiness to rush forward at once to the support of the foremost trench. This maneuver must be practiced as if it were a regular drill. Local conditions may make it necessary to station part of the supports in the third trench.

15. *Sector reserves.*—The fighting strength of both the front trenches would be soon exhausted if the sector reserves were not put in. They must therefore be brought close up in good time, either into the third trench or into special reserve trenches. In case of an attack, they should be moved forward into the second (or third) trench, to replace the reinforcements which have already gone forward (the supports) and continue the task allotted to the latter. Should the enemy's fire permit of an advance across the open, this is always preferable to an advance along the communication trenches.

The sector reserves must not, therefore, be saved up too long, but must be thrown in early. Otherwise they will arrive too late. Every battle has shown that trenches which are either lost or in dispute may be comparatively easily cleared or recaptured when this is undertaken immediately. I expect leaders to show the greatest determination and initiative in such cases.

16. *Divisional reserves.*—The sector commander must be relieved of anxiety as to his forces being exhausted too soon by moving up the divisional reserves. They should not be left behind in villages in the rear, but should be brought up to reserve trenches on the battle field as soon as the threatened sector can be ascertained from the direction of the enemy's artillery fire. Whether they stay there one day or several days is a matter of indifference. The divisional commander must rely on reserves being passed on to him by the corps commander, just as the latter expects them from the army commander. In critical situations it is not sound to quarter reserves in villages immediately behind the front. It has nearly always proved impossible to assemble the troops quickly when they are scattered in numerous cellars, etc., in a village which is being heavily shelled. In such cases the reserves should be in the trenches.

Reserves can not be rapidly moved forward without practice. This operation must therefore be practiced in suitable weather.

The distribution of the division and the improvement of the position also will be decided in the light of the experience gained in practicing this operation. Routes will be marked out. They must lead around villages, which are certain to be heavily shelled. Cavalry officers will be trained to guide troops into positions which are unknown to the latter. The Second Reserve Ulanen Regiment will find guides for the Second Guard Reserve Division; the Fourth Squadron, Sixteenth Ulanen Regiment, those for the Fifty-second Division; and the Württemberg Reserve Dragoon Regiment, those for the Twenty-sixth and Twenty-eighth Reserve Divisions.

17. *Means of communication.*—Communication with the front must not be interrupted. Consequently several means of communication must be available and kept thoroughly tested (telephones, light pistols, light-signal sections, runners, etc.). The principle of metallic circuits will be adopted for the front line in order to prevent the enemy from "listening." (For the method of laying buried cable see par. 27, "Telephones.")

18. *Machine guns.*—When the ground permits of machine guns being employed on commanding points in the second and third trenches with a view to firing over the first trench, every advantage should be taken of it. It is advisable to employ the bulk of the machine guns not in but behind the first trench. When fixing their siting the possibility of delivering both frontal and flanking fire must not be forgotten.

Used as an emergency garrison for the intermediate or second-line position, they may prevent a break through if the enemy succeeds in overrunning the first-line position.

Machine-gun units are particularly suitable for employment as a commander's mobile reserve.

19. *Minenwerfer.*—As soon as a hostile attack is imminent it is advisable to withdraw the Minenwerfer from the first trench and place them in prepared positions in the second or third trenches. Light Minenwerfer in particular will be sited in such a manner that, by making full use of their range and mobility, all points where the enemy may be expected to concentrate his infantry can be brought under fire, which should be flanking fire whenever possible.

20. *Hand grenades.*—Training in grenade fighting will be carried to the point of thoroughly instructing all officers, noncommissioned officers, and men of the infantry and pioneers, Minenwerfer companies, searchlight sections, gunners, and observers

of the field and foot artillery, as well as those detachments of cavalry which take their turn in the trenches, and the field companies of ammunition columns and trains. Officers and noncommissioned officers must, in addition, know how hand grenades should be tested and stored. Our hand grenades are not weatherproof, and in this respect their design leaves much to be desired. When storing them particular stress must therefore be laid on protection against wet. Corps headquarters will endeavor to maintain the stocks of hand grenades with the units of the reserve corps on the following scale:

Infantry regiment	8,000
Independent infantry battalion (and fourth battalion ninety-ninth reserve infantry regiment)	3,000
Pioneer company	750
Battery	50
In divisional reserve	8,000
In corps reserve	30,000

Rifles and hand grenades will be kept in the dugouts, not at the entrances to the dugouts or in special stores.

21. *Light pistols.*—Only white lights will be used for illuminating the foreground. On dark nights, ample use will be made of them. On occasions when small enterprises undertaken by the enemy have led to our first trench being raided and the garrison surprised, this has always coincided with a lack of illumination of the foreground. The second army has been asked to increase the supply of light pistols.

(For light-signal cartridges for barrage fire, etc., see par. 33, "Light signals.")

22. *Ammunition.*—Iron ration:

	Rounds.
Infantry, per man, carried in the pouches	150
In every battalion sector, per man	150
	300

Machine guns:

With each gun	in belts	5,000
Reserve for each gun	loose	5,000
		10,000

The small-arms ammunition carts of the infantry and of machine-gun units will always be kept filled.

The expenditure of light-signal cartridges and of material for close-range fighting (grenades, etc.), should be in no way restricted by the figures laid down in the instructions issued by

the corps. Expenditure in the front-line trenches will be regulated only by requirements and will be immediately replaced from the rear. Thus, as in the case of ammunition, there will be a constant stream of supply from rear to front. The resulting drain on the reserves in the rear will be covered by further indents.

IV. Artillery Positions.

23. *General.*—Each divisional sector must have at least twice as many battery positions as the number of batteries present. Batteries are responsible for keeping these positions in repair. A battery position is not complete until it is provided with observation posts, gun emplacements, dugouts for the men, and dugouts for ammunition. These latter must contain the increased "iron ration" required for repelling an attack. The amount of this "iron ration" is shown in the following paragraph:

24. *Ammunition.*—Iron ration:

	Rounds.
Field gun battery	2,000
Light field howitzer battery	1,500
10-centimeter gun battery	1,500
Heavy field howitzer battery	1,000
21-centimeter mortar, each	100
German 12-centimeter gun battery German 15-centimeter gun (Ringkanone) battery Russian 15-centimeter gun battery	800
Belgium 8.7-centimeter gun, each	80
9-centimeter gun, each	130

In addition each field gun must be provided with 12 case shot and each 9-centimeter gun with 5 case shot.

A guide to the construction of battery positions is given in the appendix (not received).

25. *Battery positions.*—I forbid any gun being placed in position in the first trench of the first-line position. Belgian 5.7-centimeter and 8.7-centimeter guns may be employed in the defense of the second-line or intermediate positions. In exceptional cases they may be employed to defend heavy batteries or the rearmost trenches of the first-line position. None of the other guns will be sited in advance of the intermediate position. Every battery position will be protected against attacks at close quarters by a special wire entanglement. Hand grenades, 50 for each battery, will be kept in the battery positions

in separate recesses. A supply of demolition explosives will be kept ready near the old guns for which there are no teams, and the personnel will be instructed in their use. If the enemy advances and it is not possible to withdraw these guns, they will be destroyed. Should it be found impossible to destroy the ammunition, it will be rendered useless by unscrewing and removing the fuzes.

In cases where the battery possesses only one of the topographical section battery plans, it will be kept in the battery position.

26. *Observation posts.*—It is advisable for each battery to have at least two observation posts. Where conditions permit it, the main observation post will be close to the battery. All observation posts will be shell proof. The enemy's attention must not be attracted to observation posts by movement to and from them; notice boards must be placed on paths leading to them, pointing out the necessity for proceeding with caution.

Auxiliary observation posts will be situated in or close behind the infantry position. From them will be observed the fire of individual batteries on special targets, such as sectors of trench, trench mortars, and machine guns.

The artillery liaison officer attached to the infantry must be at the infantry commander's battle headquarters or in its immediate vicinity.

27. *Telephones.*—Buried cables have proved very successful in the reserve corps. When crossing the open they are buried to a depth of at least 5¾ feet, and in trenches they are laid at least 2¼ feet below the surface of the sole of the trench. When laying new lines, a greater depth is advisable (6½ feet and 3¼ feet). Further, when cables are led into dugouts, command posts, etc., they must be laid underground. The most important messages sent back from the front and to the artillery are "Barrage" and "Gas attack." The line will be cleared for them, and they will take priority over every other conversation.

28. *Counter-battery work.*—Our artillery is registered on all known artillery positions of the enemy, and each battery on every artillery target within range. Preparations for a hostile attack include the deployment and registration of a very large number of batteries. During this period the enemy's artillery must be constantly weakened by shelling individual battery positions which are known for certain to be occupied; the procedure should be based on the following principles:

Evidence of the battery position being occupied will be obtained by means of aeroplanes, captive balloons, or bearings taken by the survey sections.

29. *Survey sections.*—The survey sections take bearings at night on the flashes from the enemy's guns and report the results to the artillery commanders. Only cases in which three or four bearings are obtained will be taken into consideration. For purposes of observation by day the sector of the enemy's front will be divided into groups. The survey stations will observe which groups are firing, the number of rounds fired, and the targets.

When a battery is registering by means of the artillery plan, auxiliary points lying as nearly as possible in the line of fire will be selected, on which the survey sections will register. Fire will then be corrected in accordance with the measurements, on the plan, of the distance between the point registered and the target.

30. *Balloons.*—Registration by balloon can usually only be carried out in very clear weather and on a calm day.

31. *Aeroplanes.*—An aeroplane which is registering must be escorted whenever possible by a battle plane. This is quite feasible under present conditions, if the aeroplane keeps over our lines while registering, for it can then be protected by a Fokker. Over his own lines the enemy enjoys superiority over us by reason of the number and design of his battle planes.

A number of batteries, which have been selected for bombardment, must be indicated to the aeroplane observer. Battery commanders must arrange with the aeroplane observer before they shoot with regard to target, fire procedure, and method of transmitting the results of observation. On a day previous to the shoot, the aeroplane observer must have flown over the batteries concerned in order to decide which batteries are easily and which are not easily observed from the air.

Registration will close when at least two groups or salvos have been observed to fall correctly.

Aeroplane observation will also be continued during the first part of the fire for effect. Should the shots fall correctly at the beginning of this, the aeroplane observer has fulfilled his task and is free to return home. The battery commander must be told how long the aeroplane can fly over the enemy's battery (petrol capacity, outward and homeward flight). The survey stations must take bearings during the first portion of the fire

for effect, so that the fire may also be controlled after the departure of the aeroplane.

The enemy's battery should be not merely silenced but destroyed. This will require about 150 rounds from a (15 centimeter) heavy field howitzer or 100 rounds from a (21 centimeter) mortar.

As soon as possible after the shoot, the target should be photographed from another aeroplane in order to ascertain its condition and the effect of the rounds fired.

32. *Method of engaging the enemy's infantry.*—When an infantry attack is threatening, intense artillery fire will be directed on the enemy's trenches (Corps Orders, Ia. 693, Secret, of 12/5/16, par. 7).

When the assault is launched, barrage fire will be opened (Corps Orders, Ia. 693, Secret, of 12/5/16, par. 7).

33. *Light signals.*—Cartridges which produce a red light breaking into "pearls," will be used as a signal for barrage fire. Should our fire be too short and fall on our own trenches, the range must be increased. In this case cartridges which produce a green light breaking into "pearls," will be used. It is advisable, where the ground is suitable, to have observers in lookouts placed high up and near the batteries, who can see the light signals sent up from the front line in spite of smoke and clouds of gas. All light-signal cartridges must be preserved from the damp as much as possible (packed in wooden cases, etc.). These cartridges will be issued on the following scale:

For the company furnishing the garrison of the trench and the supports, 100 red and 70 green.

For each division for instructional purposes, 150 of each.

As divisional reserve to replace unserviceable, 100 of each.

Light signals are, however, only one of the signs used to denote the necessity for opening barrage fire or for lifting artillery fire. The artillery should never delay in opening fire when the intensity of the enemy's artillery fire leads to the supposition that an attack is imminent. When the artillery fire in any particular sector is already fairly heavy, the right moment may easily be missed. In such cases the artillery, so far from waiting for light signals or telephone messages from the infantry (both means of communication may fail), should shell the enemy's trenches with an intensity increasing in proportion to the enemy's fire, in order to prevent his infantry from leaving its trenches. Immediately it becomes evident from the enemy's

artillery fire at what point he intends to break through the fire of every battery, with the exception of the (21 centimeter) mortars, will be directed onto the portion of the enemy's front-line trench which is opposite the sector threatened. Battery commanders have necessarily to act on their own initiative in this matter. The (21 centimeter) mortars will shell the enemy's assembly trenches, which have been previously located. Should the enemy launch an assault, barrage fire will be opened.

34. *Practice in fire control.*—The rapid concentration of fire on the enemy's points of assembly is difficult to achieve and must be most carefully practiced in every detail. Divisional artillery commanders will test the smooth working of the methods of indication of targets and transmission of orders by carrying out fire-control drill. This should be based on the various possible schemes of attack. The various distributions of fire will be noted in the fire-distribution books of the batteries. As a check, each battery engaged will fire a round at its allotted sector. Every possible contingency will be dealt with at fire-control drill. Divisions will cooperate with this object. The senior artillery commander will direct the fire-control drill when practicing against sectors requiring the cooperation of the artillery of two divisions. Fire-control drills must be treated from a tactical point of view. Information of the enemy's movements may suddenly reach the rear from the front line or the signals may be observed in rear.

The limits of the artillery sectors correspond more or less to those of divisions. In a divisional area the artillery fire control is in the hands of the artillery commander. The latter directs the artillery groups, which are usually composed of field and heavy guns.

(Signed) V. STEIN,
General Officer Commanding.

MEMORADUM.

TO BE GIVEN WITH ATTACHED LETTER TO ALL PILOTS AND OBSERVERS IN SECOND BRIGADE, ROYAL FLYING CORPS.

It is a matter of common knowledge and comment that, since the war began, measures for the purpose of denying the enemy information about our military and naval operations have become more stringent and numerous as the necessity to obtain it has become more urgent and vital to him.

The magnitude and issues of the war seem almost too vast for one man to contemplate, and to this is due, in all probability, the continued indiscretions of officers and men in disclosing information, for they find it hard to believe how many details learned by the enemy of the movement and location of an individual man or unit can in any way affect the result of operations and consequent duration of the war. They fail to realize that, although one such instance as an isolated fact would not, in all probability, be of as much value to the German great general staff, yet the ramifications of the enemy's intelligence system are purposely wide in order to collect such small details, and "on dits," the accumulations of which enable hypotheses to be verified and deductions to be confirmed.

The average flying corps pilot or observer has great opportunities of knowing the program of operations, the disposition of troops, and the material available not only of the royal flying corps but of the corps and army with which he is working. This knowledge is a sine qua non of his work. The enemy knows this well, and hence the capture of a pilot or observer is an opportunity for obtaining information which he spares himself no pains to take advantage of without scruple as to the method he employs or the trouble he spends.

What is written on attached is in the form of an open letter addressed to every pilot and observer in the second brigade, in the hope that he will bring himself to realize that he may be placed one day in circumstances where personal honor will make it incumbent on him to act in a manner which discipline would be powerless to enforce.

If you are unfortunate enough to be compelled to land behind the German lines you may be agreeably surprised by the apparent hospitality and generosity of your welcome there. The German officers will probably have you to stay with them as their guest for a few days at one of their squadrons, and will make you most comfortable. You will probably be extremely well entertained with the very best of everything they can offer. An abundance of good champagne from France will oil the wheels of conversation between the officers of the German Flying Corps and one whom they will probably term a brother officer of the English Flying Corps. They will appear to be very good fellows—straightforward, cheerful, and keen on the scientific side of flying, apart from their ordinary work, with which they may say they are quite fed up. They will probably lead you to talk about the possibilities of aviation after the war, and profess little interest in aviation as actually applied to the war. It may not take much wine to gladden your heart, and to induce you to lay aside your suspicions and reserve, and forget the guile which lies behind their artless questions.

And so, unaccustomed as you are to this form of deceit, you may fall another victim to this clever combination of cunning and hospitality. But though they may succeed for the moment in making a favorable impression, you will afterwards have every reason to remember that during this war the Germans have proved themselves to be a cruel and unscrupulous enemy, but they are sound financiers, and have an eye to good investment. It does not cost them much to entertain you well, and even if it did, they expect to get an adequate return for their money in the form of information unwittingly imparted by you.

That is why they will give you all the delights of the "Carlton" and "Savoy" with none of the regrets of an overdraft at Cox's, and that is why you will be treated as an honored guest, instead of being half starved in one of their now notorious prison camps; a treatment which is in fact only postponed until they have squeezed every ounce of useful information out of you. The work is done by experienced men. Quite unknown to yourself, one or more of the seemingly irresponsible flying men are highly trained intelligence officers, who will sift bits of useful information from your most brilliant "bon mots" received with the keenest amusement and gratification.

On the other hand, different methods may be employed, though these are not so common with prisoners of the flying corps as with others. You may be browbeaten and ordered to disclose information on the pain of suffering severe penalties if you refuse. Remember this is only a ruse, and that they will not carry out their threats. It is more probable that they will respect you for your patriotism and discretion.

It is quite possible that you may be placed in a hut with an officer alleged to be an English prisoner, speaking English fluently, and knowing many people in England well, and wishing to have news of everyone and everything; or perhaps he will ask no questions, relying only on your confidences. It will be difficult for you to believe that he is not a companion in misfortune, but this is a common trick of all intelligence services, and a very profitable one.

Therefore be on your guard, and remember that in a show like this it is impossible for any individual not at the head of affairs to say what is of use to the enemy and what is not. Remember that any information you may inadvertently give may lengthen the war and keep you longer in Germany; may cost the lives of many Englishmen; may strain the country's resources even more than they are being strained at present. Don't think this is all imagination and needless caution. The need of it has been bought by experience. No careless or irresponsible feelings ought to weigh with us against anything we can do to hasten the conclusion of the war.

HINTS ON RECONNAISSANCE FOR MINES AND LAND MINES IN THE AREA EVACUATED BY THE GERMANS.

(Compiled chiefly from notes forwarded by Inspector of Mines.)

The greatest care must be taken when reconnoitering ground evacuated by the Germans for mines and land mines.

A cursory examination is not sufficient, as the mines are often extremely well concealed.

The following suggestions, compiled from various sources, may be of use to officers making these reconnaissances:

CROSSROADS.

Crossroads are often mined and the charges have been known to explode as long as 48 days after our occupation. The surface of the road should be carefully examined for signs of fresh work. Any found should be at once opened out to insure that there is no contact mine there. (Sketches of typical examples—Nos. 1, 2, 3.)

The ground should be cleared for 25 yards in every direction from the crossroads and carefully inspected for signs of the entrance to any gallery which may pass under the road.

The entrance may be blown in or covered in by the débris from another explosion after the charge has been laid. Any small craters should, therefore, be carefully investigated.

The following examples have been found:

1. In Noyon galleries had been driven from under the paving stones.

2. Gallery driven under road and excavated till only a thin crust remained; 8-inch shell in position with the fuze portion on but loose and in contact with the roof.

3. Shell holes on a road, apparently filled up with bricks, etc., have been found to contain land mines fitted with instantaneous fuze and friction fuze lighter, with safety pin attached to trip wire (which had broken off).

Any dugouts left undestroyed should be carefully examined.

Look for any sets from which the tenons have been cut and replaced by wedges.

Loose boards in floor, sides, or roof often locate the smaller variety of charges.

Apparent dead ends should always be inspected carefully; the two biggest charges were found behind such places, complete even to the pick marks one would naturally expect.

Every alternate set should be removed and replaced.

The following examples of what have been found may serve as a guide to what may be expected:

1. Grenades liable to explode when trodden on.

2. Dozen stick bombs, arranged to be fired by wire attached to sandbag which had to be removed to open a dugout door.

3. Wires to fire charge attached to handrail in entrance of dugout. (In dugouts constructed with casing, mortise, and tenon joints the position of a charge is sometimes indicated by the wedging of the timber, where sides have been cut and removed.)

4. Charges of 2,000 pounds with 20 feet of tamping in wall of dugout connected with a pair of fire leads amongst a number of telephone wires. (Intended method of fire not discovered.)

5. In two cases charges of a few hundred pounds left in undamaged dugouts, which were attractively equipped so as to induce early occupation, exploded about eight days after enemy evacuation, presumably by clockwork or other delay-action device.

6. A shovel stuck in the side of a dugout between timbers. The wires from battery of three dry cells were one attached to metal and the other to contact plate. The shovel stuck out as an obstruction and would in the ordinary way have been removed.

7. A false step in the stairway of dugout of thin planking making contact when trodden on.

8. A blown-in entrance to a dugout is not always a safety sign. Charges may be concealed in the unblown portion. They are generally crudely arranged contact charges.

9. An elaborate and neat trap has been discovered under the Achiet-le-Grand-Bapaume Railway embankment, southeast of

Bihucourt. Above the timber ceiling of a tunneled stairway leading to dugouts under the embankment was a mine, to which access was obtainable only by removing three of the setts (frames) of the stairway. Every sett was intact and carefully wedged, there were no gaps, and the hand rails were continuous. (Sketch 4.)

10. A window weight, suspended by a fine cord crossing entrance, arranged to drop into a box of detonators in connection with charge.

11. One of the pieces of timber on the side of the stairs leading down into a dugout projected slightly inward at the top, though it was in place at the bottom. It was pulled out for investigation, and a nail was found driven through its lower end, the point of which was placed against the cap of a cartridge which had a charge of explosive behind it. Had the plank been forced into its correct position, the nail would have struck the cap and exploded the charge.

12. Branch placed over entrance to dugout as if to conceal it, when removed caused an explosion 2 minutes later, completely destroying dugout.

13. Trip wires in entrances of dugouts, etc., arranged to explode charges or grenades.

14. Charges have been found in chambers on each side of the entrance, in chambers off the dugout itself, in the ventilating shafts.

15. Charges are usually found to be 80 to 150 pounds of Perdit placed in small chambers at a height of 5 feet from the floor, and in the ventilating shafts 10 feet or 11 feet below ground level, and in every case at the end of a little gallery 4 feet long by 18 inches square. The charge is tamped with a wooden panel, backed by loose stones cemented over at the end. Firing is electric by armored cable.

HOUSES.

A house of any size left standing should always be looked upon with suspicion. The cellar especially should be carefully examined and the surface inspected and ground around the house cleared of débris, as mines are sometimes sunk against the wall of cellar.

The following examples have been found:

1. A box of explosives buried in a cellar, timed to go off by the corrosive action of acid on a steel wire. (Sketch 7.)

2. Charges, with fuse and detonator, in chimney.

3. Detonators in lumps of coal.

4. Book on table, with wire down leg of table. Charge would fire if book were lifted.

5. A mechanical fuse igniter attached by wire to an explosive charge fixed in the walls of a house has been found in Neuville-Bourjonval.

6. In the paving of a house in Roye the Germans had sunk a hole from the ground floor to a stone drain 5 meters below the ground level; under this drain there was a concealed shallow well; from this they had driven out two small galleries and charged them each with 150 pounds Perdit. The hole to the drain had been filled in again and repaved.

7. The French experimented successfully for clockwork devices by means of the geophone.

8. Grenade under loose brick in floor of stable covered with straw. Pressure on brick would explode grenade.

RAILWAYS.

Especial care should be taken with the investigation of the following places for signs of enemy work:

Bridges.—Charges are often placed on the girders, or holes are sunk in the abutments behind the girders.

The approaches to a bridge which has been destroyed should be examined. Trap charges have been discovered which were laid with a view of destroying the temporary structure over the gap.

Level crossings.—In some cases mines have been driven under the crossing by means of an inclined gallery from the flank.

Embankments.—Charges have been discovered at the ends of galleries, driven into the embankment. A land mine was discovered fixed inside a rectangular box 8-inch by 8-inch section, 10 feet long. This box was sunk vertically in the embankment between the rails. One foot of earth was rammed in on top of the explosive, which was to be fired by electrical means.

WELLS.

Wells are often destroyed by boring a 6-inch hole, 10 to 20 feet deep, a few feet to one side of the well, filling this with explosive, and blowing it. (Sketches 5 and 6.) The following tips for locating wells blown in this manner may be of use:

1. The German sign for a well is a white board bearing a red ring with a red disk in center, or the word "Brünnen."

2. The locality of a well is usually a crater in the yard of a building. The charges are usually placed about 12 feet from side of well, 10 to 20 feet deep, so that the well is never in the center of crater.

3. Men employed reclaiming a well should work with a life line on. Novita sets should be handy in case of any men becoming gassed from fumes of explosive which was burnt.

4. Wells and ponds have been rendered unfit for drinking by means of creosol, dung, and all sorts of filth. Wells should be labeled "Not to be used" until the water has been tested by the local expert.

BATHING PLACES.

Pointed stakes have been found driven in with their points below water level and interlaced with barbed wire.

Bathing places should be examined before being taken into use by the troops.

GENERAL.

The following remarks may be useful as regards the search for and destruction of an enemy's land mines. Great skill and care are required. Suspected localities should, first of all, be studied with good field glasses. The following signs should be looked for: Freshly turned-up earth, settlement of the ground, oval marks on the ground after rain, patches of grass that stand out conspicuously, narrow strips where the earth has been disturbed which may mark where leads have been laid, ends of wire, cord, and canvas sticking up, numerous foot tracks on a confined space, litter of materials, such as powder, guncotton, shavings, paper. Suspicious places in soft ground can be investigated with a probe. If a contact mine is discovered, it should be marked and destroyed later by firing a slab of guncotton on top of it. Trip-wire mines can be destroyed by attaching a guncotton primer to the wire and detonating it or by firing the mine by means of a long cord made fast to the trip wire. When the leads of observation mines are discovered they should be cut singly and the ends turned up. Contact mines have sometimes been exploded by driving cattle over them. The following devices have also been discovered:

1. Barricades interlaced with wires attached to stick bombs.

2. Hand bombs buried in trench with telephone wires attached.

3. Trench boards, new in every case, on several fire steps, which detonated bombs when trodden on.

4. Seven-inch shells with fuze removed and replaced by detonator.

5. Cap badges, artificial flowers, bits of evergreen, pieces of shell, and other articles likely to be picked up as "souvenirs" attached to charges.

6. The preparations for blowing up Fort de Conde appear to have involved charges of 2,600 to 3,000 pounds, to be fired independently after the fort was captured. The electric leads were duplicated, one being apparent and the other buried 1½ to 2 feet below it.

EXPLOSIVES.

The explosives used by the Germans are Westphalite, Perdit, and Donarit. They are all hygroscopic. Charges found by the troops may, therefore, be rendered reasonably safe, in the first instance, by being saturated with water. They should be left in situ to be removed by men accustomed to handle explosives.

The withdrawal of charges must be done with care, as detonators are frequently found distributed throughout them. This is specially the case with portable charges made up in tins. Detonators have been found in the middle packets of one of these. Each charge should be opened for examination.

Exploration for charges leads to the accumulation of a large amount of loose explosive, which is unfit to return to store. This should be destroyed as soon as possible in one of the following ways:

1. By detonating it in small quantities, in consultation with troops in the vicinity.

2. By scattering it broadcast over waste ground. It should be remembered that if the ground is subsequently occupied by animals as picket lines they run some risk of being poisoned.

3. By burning, the explosive being laid out in long parallel lines about 6 inches high. This is the best and safest way, provided all detonators have been removed. The fumes are unpleasant, and the explosive should be burnt after consultation with the troops in the neighborhood, and carried out when the wind is in the direction which will cause least inconvenience.

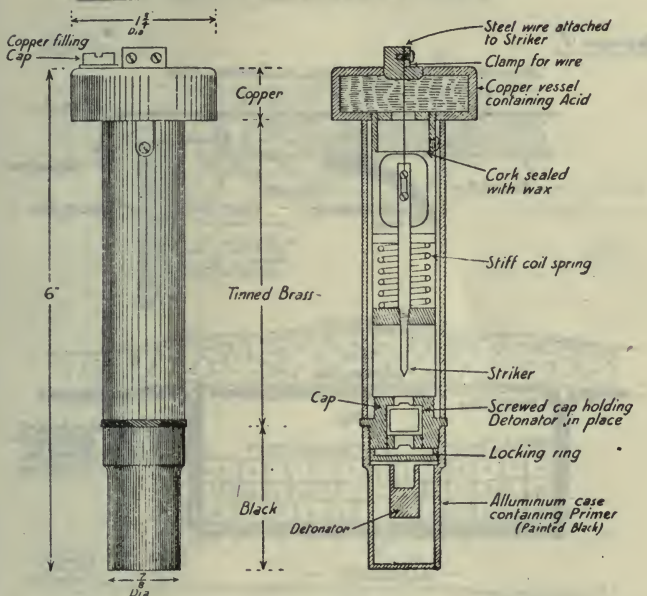
4. Ignition of the explosive is facilitated by mixing with it a little cordite or the charge of German howitzers.

Charges must not be destroyed by throwing them into ponds or down wells.

SKETCH No 7

GERMAN AUTOMATIC DETONATING DEVICE

USED IN CONNECTION WITH EXPLOSIVE CHARGES LEFT IN DUG-OUTS, BILLETS & ELSEWHERE.

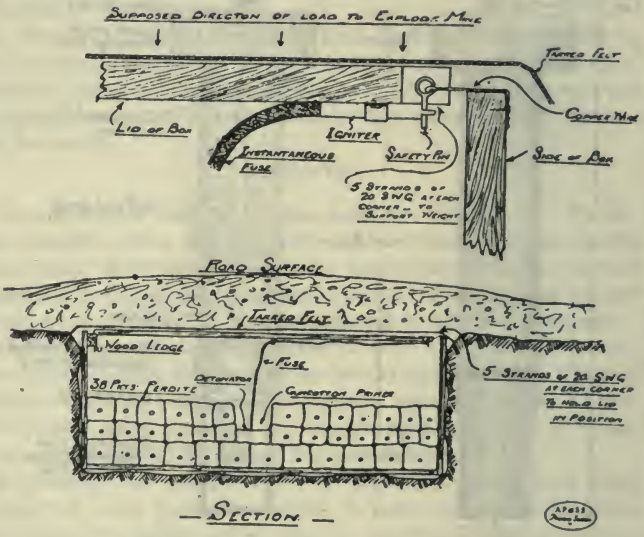


ELEVATION. SECTIONAL ELEVATION.

The device shown above is exceedingly dangerous and explodes automatically after a certain length of time, owing to the chemical action of the acid severing the piece of fine wire and thus releasing the striker.

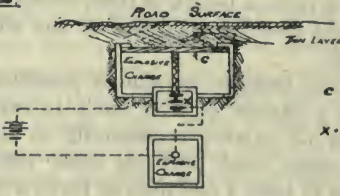
The device should be handled as little as possible after it has been removed from a charge, as it is liable to explode at any moment. It should be carried horizontally at arm's length, holding it by the copper head, with the other end away from the body, and buried at least 1 foot deep or thrown into a well.

Sketch 1

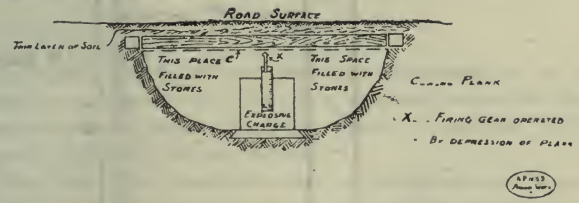


— Section —

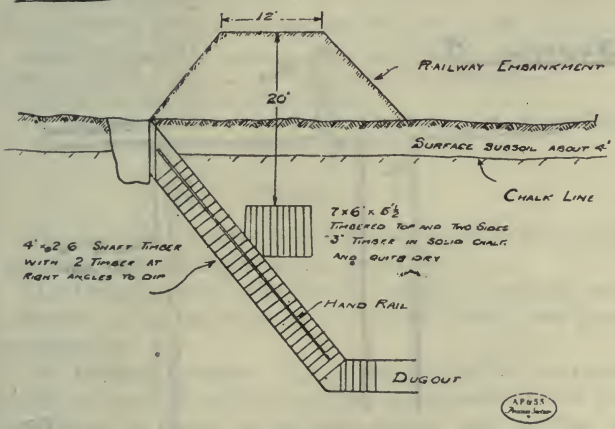
Sketch 2.



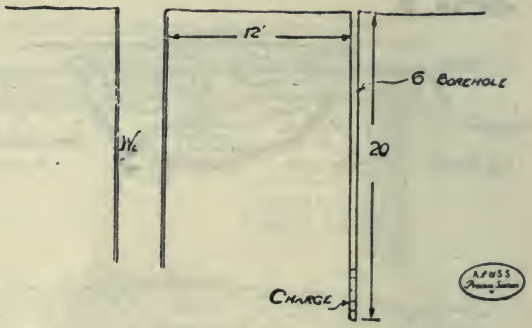
Sketch 3



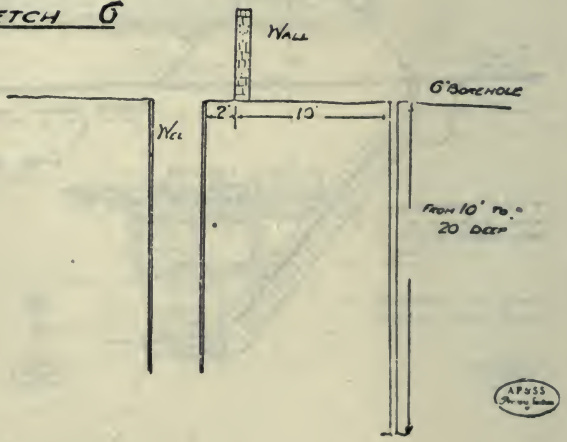
Sketch 4



SKETCH 5



SKETCH 6



DIRECTIONS FOR THE USE OF ANTIGAS HORSE RESPIRATOR.

ALERT POSITION.

When horses are being sent into the neighborhood of the trenches, the transport, or other officer responsible, should have the respirators adjusted into the "alert" position before moving off. This is done as follows:

(*a*) The flap of the respirator case is unbuttoned and slipped under the noseband of the headcollar from below upward

(*b*) The straps on either side of the case are also passed under the noseband and secured to the cheek pieces of the head collar above the metal **D** on each side.

(*c*) The small unbleached calico patch on the upper side of the opening of the respirator is buttoned onto the noseband so that the respirator is ready to be slipped on immediately.

(*d*) The cover of the case is then closed over the noseband and the respirator thus protected from rain, etc. (See Fig. 1.)

NOTE.—Should it be found that the respirator carried in the "alert" position galls the nose, it may be carried as an alternative—

(*a*) On the saddle, for riding horses.

(*b*) On the breastplate attached to the rings of the supporting strap or on the supporting strap itself, for draft horses.

WEARING IN GAS.

The respirator carried in the "alert" position can be rapidly adjusted when necessity arises, as follows:

(1) Unbutton case and remove respirator, leaving the case attached to the cheek pieces of the head collar and lying flat on the face.

(2) Holding the lower side of the opening of the respirator with one hand on each side of the canvas mouthpiece, draw it down over the upper lip and upper incisor teeth into the mouth. Gently enlarging the opening of the respirator, adjust it well up into the angle of the mouth (the linen portion which is buttoned onto the noseband will prevent the bag from slipping off the nose).

(3) Then take the elastic band on either side close to the mouthpiece and pull outward so as to tighten the mouth of the bag over the upper jaw above the nostrils. This is most important, to permit of sufficient length of loop of the elastic to go over the horse's poll, and also to insure the respirator being gas-proof.

(4) Slip the elastic loop over the horse's poll (vide Fig. 2), or, in the case of a restive horse, or when the attendant is a very small man and unable to reach the horse's poll, draw the elastic loop taut from each side of the mouth, thence under the lower jaw, and fix securely to the lowest portion of the throat lash. (Vide Fig. 3.) The respirator is then in position, and the animal may be worked in it without difficulty or undue distress. The bit and reins are not interfered with in any way. **(See Figs. 2 and 3.)**

REPLACEMENT IN CASE.

In folding the respirator and replacing it in the case the following points should be observed:

(1) The canvas mouthpiece should be wiped as clean as possible.

(2) The bag should be held with the canvas mouthpiece downward and the elastic band looped round the bag. Commencing at the sack end, roll tightly over the elastic band. Afterwards insert into the case with the linen flap uppermost.

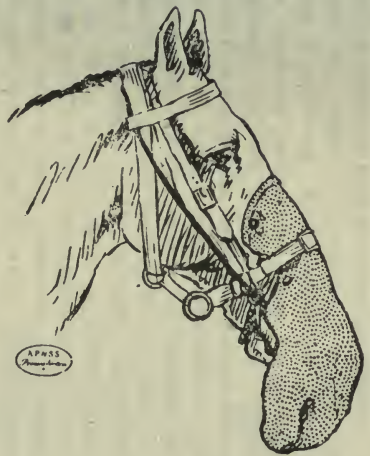
J. MOORE,
Brigadier General,
Director of Veterinary Services.

HEADQUARTERS, D. V. S.,
June 1, 1917.

Fig I

Alert Position.

Fig II



Respirator adjusted and secured by elastic over poll.

Fig III

Respirator adjusted and secured by fastening elastic to throat lash.

PATROL AND CONTROL OF "NO MAN'S LAND."

RECONNAISSANCE.

1. There should be drawn a more or less arbitrary line between observation and reconnaissance. Both duties are performed by the battalion intelligence sections, but by entirely different sets of men.

By observation is meant the method of obtaining data from stationary observation posts, while by reconnaissance is meant the method of obtaining data by means of patrols.

2. At the very outset it is necessary to point out the vital importance of this work. Even the highest authorities have no means of obtaining information about the enemy's front line, except through our own front-line troops. Without accurate information it is practically impossible to plan any operation.

A great deal of very valuable information goes to waste simply because the ordinary man in the line does not know what to do with it, or is simply too lazy to tell what he has seen or heard. For instance, a sentry, at night, may distinctly see the flash of an enemy trench mortar or machine gun. If he at once notifies his officer, and this officer passes it on to the intelligence officer, there is every chance that the enemy gun will be quickly located and put out of action. In all cases the correct procedure is to get the information to the intelligence officer at once. He will know the best use to make of it.

3. The organization of the intelligence section varies in different battalions, but the following is one that has proved successful:

1 intelligence officer (O. C.).
1 scout officer.
1 sergeant (scout).
1 corporal (observer).
1 corporal (sniper).
2 lance corporals (scouts).
4 snipers.

12 scouts.
10 observers.
1 cook.
1 batman.

35 total all ranks.

4. Under the heading of "Reconnaissance," the only parts of the above dealt with are the scout officer, scout sergeant, and lance corporals, and the 12 scouts. These men are divided into two reliefs of 8 men each, one commanded by the officer and one by the sergeant. This number is ample for all ordinary purposes. It can handle any ordinary German patrol of from 12 to 15 men, due to the better moral training and bombs possessed by our men. A larger patrol than this is difficult to conceal properly and can not get as close to the enemy without being seen.

If for any reason, such as offensive work, a larger patrol is needed, the two reliefs can be joined, or bombers borrowed from the companies.

In order that these men shall be properly trained they should be excused from all duties except those actually pertaining to their work. For training and discipline they should be under the direct command of the scout officer.

During training special attention must be paid to the following subjects: Night firing with revolver and bomb. map reading, use of prismatic compass, and the perfection of patrol formations and signals. Besides the above, they should be trained in reporting what they have observed. It must be impressed on all that it is far better to be not able to report anything at all than to give information that is not absolutely accurate. (See Appendix "A" for typical syllabus of training for an intelligence section covering two and one-half weeks.)

5. Upon entering a new sector, it is imperative that the scout officer, after a careful study of his ordnance map and air photographs, decide on a definite plan for his patrols to work upon. The plan should be so devised that a thorough map of "No Man's Land" can be drawn up. Only too often patrols are sent out on the spur of the moment with only a hazy idea of where they are going, or what to look for. As a result, they see so many things that, not having definite orders to pay particular attention to certain features, their report is as hazy as their impressions, and of no value whatever.

At present there is a real need in France of maps of "No Man's Land." Each battalion gets, in time, a fairly accurate idea of local conditions, but this information is not put down in map form, and is carried away in the heads of the battalion being relieved; as a result each battalion is forced to duplicate work already done any number of times before, and has not time to really do the work properly. If each scout officer would put on a map, specially constructed for the purpose (scale 1/2500), all information he gathers, with the date, progressive work could be done, and in a very few weeks accurate maps could be obtained of all the "No Man's Land" in France.

The following is a scheme worked out and found satisfactory as far as the limited time of a single tour, say seven days, would allow. The work to be done was roughly divided into three parts:

(*a*) Our own front line, support lines, and communication trenches.

(*b*) Our front-line parapet, wire, and "No Man's Land" as far as the enemy wire.

(*c*) The enemy wire, location of his saps, bombing and listening posts, etc.

The first thing to be done was to prepare a large piece of tracing paper by drawing in the map squares to a scale of 1/2500. Then, after studying the ordnance map and air photographs, a certain amount of time was allotted to each of the above divisions according to the difficulty of the work in each case.

Under ordinary conditions it worked out about as follows:

6. During the first and second days, three observers make a detailed study of our lines as far back as battalion headquarters. During this time the battalion has the use of three observers from the outgoing battalion, as explained under partial reliefs, and, therefore, has three spare men. During the same time all scouts make a complete tour of all our lines and study the observers' maps. This is necessary, as the scouts are guides for the battalion and visiting staff officers.

The scout officer compares the observers' maps with the latest ordnance maps and notes any differences of which, after personal investigation, he notifies the brigade. It often happens that the ordnance maps are wrong, or that new work has been done since they were printed.

7. *First night.*—On the first night in a new sector the scouts go no farther out than our own wire, and working from one

flank make a thorough investigation of our wire, front-line parapet, and prominent objects in the back country. This may appear trivial work, but it is of great importance in the work to be done later. Before a patrol can go into the enemy wire it must know all gaps in our wire for purposes of exit or entry, must be able to recognize prominent features in our parapet and back area, so as to be able to locate themselves by bearings when out in "No Man's Land." It does no good for a patrol to be located at gap in the enemy wire, or a post, if it does not know where it is itself; unless exact map locations of points seen on patrol can be given, the information is of little or no value. If a patrol knows all the marks in our parapet (usually a sky line), such as piles of sand bags from a mine sap, high points in the parapet, isolated wooden posts, etc., or knows the outlines of buildings, mine shafts, haystacks, hills, clumps of trees, etc., in the back country, it can take bearings on two or more, and these when plotted will show exactly where the patrol was at the time. This is the reason for spending the first night close to our front line. Besides this, an accurate report of our own wire is always very welcome at battalion headquarters.

Company commanders often complain that this close patrol is of no protection to the line, and this brings up a much-discussed question as to whether a patrol is responsible for the defense of the line or not. This question was finally settled by Gen. Sir Julian Byng when he very definitely stated to a meeting of all the intelligence officers of the Canadian corps that battalion scouts were to be used for obtaining information *only*, and that the company commanders were responsible for the protection of their own frontage.

Another objection company commanders raise is that the patrol masks the fire from the trench. This is true, but can be reduced to a minimum by having a scout stay on the parapet exactly abreast of the patrol. He shows where the patrol is at the time, and other parts of the line are at liberty to fire. The patrol itself can defend the point it is on, if necessary.

When working down our wire it is necessary to have a flanking party of, say, three men about 25 yards out in "No Man's Land" to prevent surprise.

8. *Second night.*—On the second night the patrols examine all craters and determine the following points:

1. Whether occupied by the enemy.
2. If so, strength and location of post.

3. State of wire protection.
4. Whether it would be practical to raid the post.
5. Height of crater lip.
6. Size of crater, depth and diameter.
7. Condition of interior with view to use as an assembly post for a raid or general attack.
8. Whether it would be practical to place a post of our own on the near lip.

It is a very difficult and dangerous piece of work to investigate a crater, and it is hard to say what is the best way of doing it. It is usually impossible to crawl right around the lip, as it is a sky line. Besides, parties manning a crater sap are usually very wide-awake. About the only way to approach is from the rear, but enough to one flank to keep away from a sap running from the crater to the enemy front line. These saps often are manned by connecting files, and if seen the patrol will get fire and bombs from three sides at once. The patrol should start well out to one flank and across "No Man's Land" until very near enemy wire, and then work along the wire toward the crater, until within about 20 yards of where the sap should be. From this point head straight toward the crater. The advantage of approaching from this direction lies in the fact that the crater party will be looking in the opposite direction, and that if seen from the front line they will hesitate to use a machine gun for fear of hitting their men in the crater.

Upon getting to within about 30 yards of the crater the patrol should be placed in shell holes and only the officer and lance corporal advance. Two men can go much closer than an entire patrol. When as close as they can get with safety, these two men get into a shell hole and wait for a flare to go up. What constitutes a safe distance can only be determined by experience and depends on the enemy's vigilance, the night, the nature of the ground, etc. Sometimes it is possible to approach to within 5 yards, and sometimes a bomb is thrown when the patrol is 30 yards away. If once seen and bombed, go back if possible, for it is useless to try to approach for hours, if at all, that night.

When the flare goes up and it is possible to observe the crater, great care must be used. The flare lights up the observer as well as the enemy. In order to observe from a shell hole, take off the cap and place one cheek on the ground and observe with one eye. This breaks the outline of the head and shoulders,

which is what the enemy is looking for, and can see for quite a distance. It is surprising how much closer it is possible to get if no definite outline is shown.

If no enemy post can be seen, bring up the remainder of the patrol and with the officer well in the lead, say, 10 yards, start making a circuit of the crater. Care must be taken not to show on the lip, which is usually a sky line. It is better to keep well away from the crater so as to be certain to be off the lip. The officer can crawl to the edge when necessary to observe the inside, though that can be done from our own side. When moving, the leader should advance one shell hole and then each of the remainder advance one. After each move quite a pause must be made in order to be certain that no enemy is around, and also to allay suspicion if the last move was uncertainly detected. By quite a pause is meant, say, two or three minutes. There is always plenty of time and such matters can not be hurried without detection.

Each crater must be treated in the same manner and the results put on the map being made.

When a number of craters are joined together and are close to the enemy's line, it is practically impossible to get any information about their far lip. They have to be considered as part of his front line, and the only indication as to whether they are held or not is to be obtained from air photos, which would show as sap leading to the crater, though that is no certain sign that the lip is manned; another sign is the firing of flares from the lip, and is a better indication than the air photo.

9. *Third night.*—During the third night the patrols examine all old trenches running across "No Man's Land." The points to be observed are:

1. Whether trench is passable for our own or enemy raiding parties.
2. Its direction, point of entry into our lines and enemy's, if possible
3. Its branches.
4. Whether it is occupied by enemy outside his own wire.
5. Whether it or its branches are fit to be used for an assembly trench for a raid or general attack.

This information is also put on the scout officer's map, which is now beginning to be of some value, and even if carried no further would save the next battalion a great deal of time and labor.

In following a trench of this kind it is usually best to place half the patrol on each side, with one man actually in the trench. If the trench can not be readily crossed, it is better to keep the entire patrol on one side except for the one man in the trench. The officer should be well ahead, as usual. This is comparatively easy and safe work, as cover is always handy and no enemy likely to be met, except from the front.

Remainder of the tour.—The remainder of the tour is spent investigating the enemy wire. This should be done in a systematic manner, working steadily from one or both flanks inward. It is best to work from both flanks, as each relief will then do a continuous piece of work and won't be starting where the previous relief left off. The starting point should be determined by means of a compass bearing from some saphead, in our line, that is shown on the ordnance map. This bearing is measured on the map and then the patrol crawl on it from the sap and can strike the desired point within a few yards. On returning, the stopping point should be located, when possible, by bearing on prominent objects in our back area or the enemy back area. As soon as the patrol returns its leader must report to the scout officer, who will put the information on his map.

When reporting on wire the following points should be observed:

1. Strength:
   - (*a*) Height.
   - (*b*) Depth.
   - (*c*) Thickness or density.
   - (*d*) Number of lines of wire.
2. Position:
   - (*a*) Of inner line from enemy front line.
   - (*b*) Distance between lines.
   - (*c*) Map location of portion examined.
3. Gaps:
   - (*a*) Map location.
   - (*b*) Width.
   - (*c*) Whether straight or zigzag.
     - (*a*) Whether left purposely for enemy patrols or cut by our gunfire.
   - (*d*) Whether it is clean or just weak spot with some wire left.
   - (*e*) Accurate report of effect of our recent gunfire or trench-mortar fire.

4. Composition:
   (*a*) Knife rests (metal or wood).
   (*b*) Apron wire.
   (*c*) Loose wire.
   (*d*) French or barbed.
   (*e*) Whether wooden or metal screw stakes are used.
5. New work:
   (*a*) Position.
   (*b*) Extent.
   (*c*) Probable time since put in.

Under ordinary circumstances it is best for two men to actually investigate the wire while the remainder move along abreast of them and about 15 yards out. One man should never go alone, for a stray shot might knock him unconscious and the remainder of the patrol not know it and lose his body.

When investigating a gap end for a raid it is imperative that the patrol officer, and usually the officer taking over the raid, go *completely* through this gap, being certain that they have passed all wire and that no obstacle remains between them and the enemy front line. There is often a row of wire just a few feet from the parapet and it must be ascertained, so that not the slightest doubt remains that this has been cut. The lives of the men going over hang on the absolute accuracy of the scout officer's report, and on this occasion no risks are too great for him to take until he is completely satisfied. He should observe the width of the gap and whether the gap is filled with piles of broken wire or has been swept clean by our high-explosive shrapnel.

If when moving down the wire an enemy advanced post is located, a wide detour out into "No Man's Land" must be made in order to avoid it.

If all the information secured thus far, supplemented by that gained by the observers, has been put on the map a very valuable document has been built up that can be given to the relieving battalion, who can work at putting in details left out during the first tour.

12. *General remarks.*—It is often a great help, when investigating enemy wire, to post a man in our front line, opposite the point where our patrol is working, with instructions to fire 1½-inch Very lights at fixed times, say, every 5 minutes, after the first 45 minutes. During this first three-quarters of an hour no lights should be fired, as the patrol is getting into position

to observe. When the time comes for the flare to be fired the entire patrol must be in shell holes and no one allowed to look out except the officer and noncommissioned officer. One should look to the right and one to the left and conceal themselves as described under crater investigation. It is necessary that the officer's watch and that of the man firing the flares should be exactly the same and that an understanding be reached that if the first flare is a dud a second or third be fired at once, the time for the next being reckoned as if the first had not failed. The light must be fired high and go over the heads of the patrol. On no account must it fall behind them, as this would throw them into relief and be fatal. A light dropping just in front of the enemy front line blinds him and shows up the wire very plainly to the patrol. If the light goes over the enemy trench it does not blind him, but still shows up the wire during its fall. The best time to observe is while the light is still in the air and before it has passed over the enemy front line. During this time it is shining in the faces of the enemy and from behind the patrol, whose eyes are not blinded. After it has struck the ground it often shows up the heads of the enemy sentinels and some idea of how he holds his line may be determined. These lights are of great assistance but are dangerous and can only be used after making certain that the man doing the firing knows his instructions. While the patrol is out no other flares must be fired anywhere near where they are working, or any at all, if it can possibly be helped. Usually the most dangerous kind of a flare is one fired way off to one flank, maybe half a mile away. Always be quiet when a flare goes up, no matter how far away it is.

Warning.—Although patrols are more or less independent, there must always be perfect cooperation between them, the infantry, and the artillery.

Every afternoon the scout officer should make it a point to see the officers commanding battalion and all company commanders to determine whether they desire anything particular done, and if not, to tell them what the plans are for the patrol during that night. If the companies are going to send out wiring parties they have a right to expect that the scout officer furnishes leaders for the covering parties. No matter what kind of work the companies intend to do in front of the parapet, the scout officer *must* be notified beforehand. He is absolute officer commander of "No Man's Land," and no man, from the

battalion commander down, has the right to step over the parapet without notifying him. One man must be in charge of "No Man's Land," and the scout officer is the logical man for the position. If any officer can go roaming around our wire he will be killed sooner or later by our own patrols or kill some of the patrols. A large number of casualties have been caused in this manner, for a man out in "No Man's Land" can not stop to ask questions, and if anyone is seen when no warning has been given he is presumably an enemy. Conversely it is just as important that the scout officer notify all parties concerned before any of his men go out.

It is not sufficient to simply notify the company commanders in the afternoon that a patrol is going out. Every man on the front affected, the battalion on the flank, and the trench mortar and artillery liaison officer must be given the following facts:

(*a*) Time of departure.
(*b*) Place of departure.
(*c*) Size of patrol.
(*d*) Ground to be covered.
(*e*) Time of return.
(*f*) Place of return.
(*g*) *Name of officer* sending warning.

Every man should be told the above by some member of the patrol. Usually the officer goes in one direction and the noncommissioned officer in the other. Not only the sentinels are to be told, but their reliefs also. The officer on trench duty should be present to see that no saps or listening posts are omitted. The warning must *never* be *passed* down the trench, as this is a certain way to make mistakes. Upon return the trench must be notified of the fact.

Before going out the artillery and trench mortars must be notified not to fire on a certain front during the time the patrol is there, except, of course, in case of emergency, when the patrol must be sacrificed.

Whenever possible the scout officer should arrange to take out as many officers and men of the battalion as possible so as to give them some experience in "No Man's Land." The confidence thus gained comes in very useful when the men are sent on wiring parties or when they "go over the top" in an offensive.

Company patrols versus listening posts.—There is much divergence of opinion amongst different staffs on the use of company patrols for the defense of the front line, but very little

amongst line officers who don't want these patrols. Still it is very common to receive orders to keep them out all night, with the result that the line is in serious danger.

These patrols are supposed to move up and down the outer side of our wire and protect our line from sudden raids without artillery preparation. Of course if there is artillery fire that is all the warning necessary.

These patrols are both useless and a menace to the line. There are a number of reasons for the above statement. A man moving in "No Man's Land" can do no observing; all his attention must be concentrated on picking his way and keeping quiet. An untrained body of men blundering along can be heard for a long distance, and any enemy party that is out would simply be quiet in shell holes until they have passed and then either enter the trench or take up positions and destroy the patrol on its return. The only time this patrol is doing any good is when lying still in shell holes and to all intents and purposes acting as a listening post. Besides being useless, these patrols are a menace, as they mask the fire of the trench and cause uncertainty on the part of sentinels. The sentinels are never certain whether a body of men is their patrol or an enemy raiding party. In one brigade enemy raiding parties got into the front line and secured prisoners on two nights running. In both cases they were plainly seen, but due to uncertainty as to identity were not fired upon. In one case the raid occurred between two Lewis guns, which were both trained on the party, and neither were fired. As a result the brigade staff ordered double the number of patrols, and, much against the advice of the line officers, just doubled the danger.

If plenty of listening posts are thrown out, they can give all the warning necessary. Little can be seen in "No Man's Land" at night, and the best way to detect the approach of the enemy is to hear them. Listening posts are best for this, as they are perfectly quiet, with their ear near the ground. Besides, they are in communication with the front line by means of tug wires, while patrols have no communication whatever.

Equipment of patrols.—Patrols should never wear steel helmets, as they click when they hit a piece of barbed wire, show an unmistakable outline, prevent crawling with the face on the ground, and it is seldom that a patrol is bothered with shrapnel. Revolvers and bombs are the only arms carried. Rifles are too unwieldly, noisy, and in a few moments are unfit to use due to

the mud. The best revolver is the .45 Colt automatic. If care is taken, no mud gets into the working parts, and the rapidity of action and reloading offset the disadvantages. In firing at night so many shots are wasted in misses that quick reloading is essential. Two Mill's bombs, carried in the hip pockets, is about all that can be carried with any comfort. All members of the patrol should be equipped with rubber suits that tie around the ankles and wrists and lace up the back. They must not fasten in front, as the strings would get tangled in bits of broken wire on the ground, and the opening let in the mud. The material is soft and does not rustle. Before going out each man should roll in the wet mud, for the mud from the previous night has dried and is of much lighter color than the wet mud. Hands and faces should also be covered with mud and also the outside of revolvers, if it is a moonlight night and the gun metal glistens. A very important thing is to have each man carry gum or peppermint to use in case he has to cough. Most scouts have colds due to being wet every night, and the strain of patroling breeds a desire to cough that it is impossible to overcome. A cough close to the enemy means certain detection.

All forms of identification must be removed from scouts, such as identity disks, patches, régimental buttons, cap, collar, and shoulder badges, pay books, and all letters. No article of clothing or equipment can have the battalion number on it, for even a handkerchief, with the number on it, if it is captured, gives all the information that a successful raid gives.

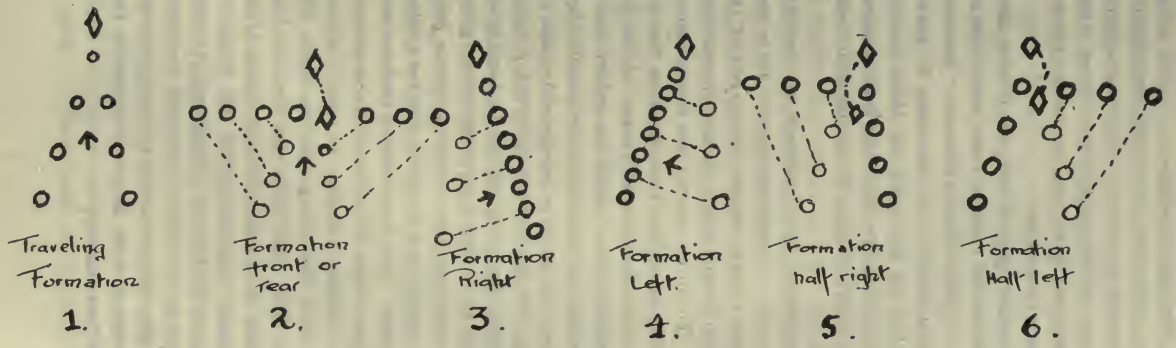
Patrol formations.—There are a large number of different formations, but the best for general purposes is the "wedge formation."

The main advantage of the "wedge formation" is that it can be formed into a defensive formation facing any direction in the shortest possible time. The best defensive formation for bombing of this nature is a line facing the enemy; first you have all your men in action; second, it is the most difficult target.

The drawings explain themselves. The officer simply calls out which formation to take, and then orders an advance or retreat according to circumstances.

It is often advisable to take a man from one of the flanks of the wedge and have him follow in rear to prevent surprise from that direction.

If any enemy patrol is met, the best policy is to form line facing them, fire one bomb apiece, and rush after your bombs


Traveling Formation
1.
Formation front or rear
2.
Formation Right
3.
Formation Left
4.
Formation half right
5.
Formation Half left
6.

have exploded. The enemy bombs are nearly always time bombs, and by rushing in close with revolvers you usually pass or leave their bombs before they explode. Another advantage of a quick rush is that if any of the enemy have been wounded or killed their comrades will not have time to remove them and important identifications may be secured.

As a rule, a German patrol will not face a discharge of Mills bombs and a determined rush of even half their number. There is little danger at 2 yards from a German "potato masher," while it is nearly certain death to be standing 12 yards from a Mills bomb. Immediately on throwing the Mills the patrol should lie down and start revolver fire until the bombs have exploded. To be standing is to court danger from our own bombs, which may kill at 100 yards.

Method of crawling.—It is difficult to describe the way to crawl without giving a demonstration. It is not necessary to get down and crawl until within 125 yards of the enemy lines, unless it is a very bright night or an unusual number of lights are being fired. To do so wastes too much time and needlessly tires the men. Up to within this distance the patrol can move by crouching or on its hands and knees. After passing the 100-yard mark, increasing care must be taken until when within 15 or 20 yards, when movement is only possible by inches. Only highly trained men can hope to escape detection at this distance.

When crawling the main thing to avoid is any sudden movement or the showing of any outline of the head or shoulders. The body should never be raised a particle from the ground so as to let any light between the two. For the same reason it is necessary to be very careful not to allow the bent elbows or the feet to leave the ground. The legs should be kept as close together as possible, and the arms not allowed to be spread out any more than necessary. Before starting to crawl the caps should be turned around with the visors to the rear. There are two reasons for this; first, that with the visor in front it is impossible to get the face close enough to the ground, and, second, that it gives the German appearance to the head. For the latter reason the caps must be turned around again before entering our own lines. When on the move never lift the head to see where you are going. The face *must* be touching the ground. If it is absolutely necessary to look, keep one cheek on the ground while doing it and use just one eye.

When a light goes up every man *must* remain absolutely still, no matter in what position he is in. Even if he is standing up in the enemy's wire, the chances are that he will not be seen if he doesn't make a move. It is instinctive to take cover when in such a position, but it is certain death to move even an arm. While a light is up it is harder to see a still object than when there is no light, because there are so many shadows thrown that a man may be easily mistaken for one. If while you are in a badly exposed position a machine gun opens, it is natural to think that it is firing at you, and the desire for cover is almost irresistible, but the chances are that you are not being fired at, and if you remain cool and quiet you will escape unhurt. This is one reason that it takes long training to make a good scout. Without practice hardly any officer or man can stand up in apparently plain view of the enemy without crouching slightly, and that is sufficient to give the party away.

As soon as seen, lights are sent up and kept in the air to hold you to your position, and then machine guns and bombs commence their work.

The instant a patrol is certain it is discovered it must get out of bomb range. It is always a few moments before the Germans can bring their machine guns to bear and get bombs off. During those few moments the patrol must get out of bomb range and into shell holes, where they must stay until the excitement is over. When things quiet down a bit, don't move at once, for often the machine guns open again suddenly in the hope that the patrol has done that very thing. During the initial retreat there will most likely be a rapid rifle fire going on, but that must be risked, and is usually not very effective at night.

Capture of isolated posts.—There is very little to be said on this subject, except that it is a very difficult and dangerous piece of work. The capture must be made without any noise, for if the main trench is alarmed lights go up, and you are held in the advanced post and bombed out at leisure. The only time when this kind of thing is practicable is when there is no wire around the sap leading back to the front line, and you can slip up the sap into the post. It is almost impossible to approach close enough above ground to force a surrender without a bomb being thrown or the alarm given. In most cases it is simpler to chance hitting a post and endeavor to enter the front line and then remain hidden behind a traverse until some one comes along, and put a gun in his back. If discovered and alone or with one man,

try to get over the parados and hide there. The enemy will not expect you there. If a party is with you, make a rush for "No Man's Land." Some may escape. These stealth raids have ceased to be a success lately, as after a year's experience the Germans are beginning to be more alert. The only practical method now of getting prisoners is to organize a real raid with artillery, as described in Minor Operations and Recent Trench Raids.

MANUAL OF POSITION WARFARE FOR ALL ARMS.

PART 5.

THE EMPLOYMENT AND DUTIES OF ARTILLERY AEROPLANES IN POSITION WARFARE.

(Issued by the Chief of the General Staff of the Field Army.)

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I. Importance and First Principles of Cooperation Between Artillery and Aircraft.

Aerial reconnaissance and observation have become more and more important for the artillery in both the attack and the defense. If aerial support is lacking and ground observation is impossible or bad, the artillery can, in the main, only carry out searching and sweeping fire, and this means a large expenditure of ammunition with poor results.

Aerial observation makes concealed targets visible. The aeroplane, and the balloon also, are therefore aids to shooting which the artillery can not do without. By their activity the result of the battle will be considerably influenced. The artillery airmen must always realize this.

The task of reconnoltering targets, keeping a check on them, photographing them, and observing fire takes the artillery aeroplane as far over the enemy's lines as any other aerial observer sent out on a minor tactical reconnaissance. The actual observation of fire can, as a rule, be carried out from our side of the line, but not always so far back as to escape the action of hostile aircraft or antiaircraft fire. The efforts of the enemy to interfere with the activity of our artillery aviators may also force the latter to accept battle. They must always remember, however, that for them artillery observation is the essential task.

Close liaison between the artillery and the airmen, mutual confidence, and the fact that such cooperation has been rehearsed are the primary conditions for success. The observer must be personally acquainted with the battery commanders of his sector, and must be familiar with the method of work of their batteries, while artillery commanders must be thoroughly conversant with what the flying service can do, and especially must have a clear knowledge of the duties of artillery aeroplanes. Personal experience gained by taking part in flights is of especial value for this purpose.

II. The Employment and Command of Aviation Units in Support of the Artillery.

An army has primarily at its disposal, for cooperation with the artillery, artillery flights, each consisting of six, or sometimes still of four, aeroplanes fitted with wireless. These flights are specially trained and equipped for artillery registration work.

On the principal fighting fronts the artillery of a divisional sector, or the artillery under the direct command of a corps commander, must have at least one artillery flight at its disposal. This flight is generally best placed under the command of the artillery commander of the division, or of a divisional or corps artillery group commander, as the most important tasks to be carried out with aeroplane observation, in particular the silencing of the enemy's artillery, come into their sphere. In order that these flights may carry out their tasks even when threatened by hostile aircraft, a certain number of protective aeroplanes (Schutzstaffeln) will be attached to them and placed under their control. Efforts should always be made to house them in the same aerodrome.

Every observer must be so acquainted with the whole of the fighting ground of his flight that he can be employed for any artillery task. A flight would not be employed to the fullest extent if an observer made a rule of always only working with the same battery. Observers should only be employed in accordance with the importance of the work in hand.

If one flight only is employed in a very large sector, and it is desired temporarily to provide certain artillery units with aeroplanes fitted with wireless, in order to carry out special tasks, the organization of these flights, when they have protective aeroplanes attached, permits of the aeroplanes being employed in sections (two aeroplanes). When the special tasks have been accomplished, the sections return to the flights. It is not advisable to employ the flights continually thus split up, as it robs the flight commander of his influence on further training, on the best technical employment of the material and its maintenance.

III. Duties of the Artillery Aeroplane Observer.

The observer's principal tasks, which are to be allotted by the artillery commander under whom he is placed, are:

(1) Reconnaissance of and keeping a watch on artillery targets,

(2) Observation of fire.

1. Reconnaissance comprises the location of all targets which can be engaged by the artillery, such as—

(*a*) Gun positions, observation and command posts.
(*b*) Antiaircraft guns.
(*c*) Position of fire, communication and cable trenches.
(*d*) Trench mortar and machine-gun positions.
(*e*) Assembly places for reserves and concentrations of troops in the fire trenches.
(*f*) Dugouts and camps.
(*g*) Ammunition dumps and railway works.
(*h*) Roads on which the principal traffic of vehicles and troops takes place.

In order to aid such reconnaissance, cooperation is necessary with the other reconnaissance units (artillery survey sections, captive balloons, wireless observation posts, officers of the higher staffs who supervise the intelligence service and maps); this should be arranged through the artillery commander or the commander of the troops.

The best method of reconnaissance is by photography, as visual proof is provided of the correctness of the reconnaissance.

Large scale photographs of the neighborhood are useful for artillery work, the results of the reconnaissance being sketched or pricked on them during the flight. In this way errors are avoided which must creep in if the observer afterwards tries to transfer what he saw to an ordinary map.

2. *Observation of fire.*—Registration by aeroplane is useful against all targets which can not be observed from the ground or from a captive balloon, and also when aeroplane registration offers advantages over these methods of observation. Registration by aeroplane is most indispensable when silencing hostile artillery and engaging distant targets; it should, however, be employed against all targets as much as possible.

Field and foot artillery must have practice in aeroplane registration. It is just the simple tasks of the field artillery (such as observing the position of the barrage, observation of annihilating fire against hostile assault and assembly trenches, etc.), which can be accomplished very much more quickly and accurately with aeroplane observation than with ground observation.

IV. Aeroplane Observation for Artillery.

A. General preparations.

1. *Organization of the wireless fighting stations.*—Communication from the aeroplane to the ground is established by means of wireless (for wireless signals and messages, see Appendix 1). Light signals can also be used (see Appendix 3).

For the reception of wireless signals from the aeroplanes, wireless fighting stations will be erected by the flight in the neighborhood of the artillery command posts.

Field wireless stations may also be used for communication between aeroplane and artillery commander.

On a battle front the following aerials should be available:

1 aerial at the aerodrome.

1 aerial with the divisional artillery commander or, in some cases, with the group commander (headquarters aerial).

1 aerial, if possible, with each subgroup of heavy and field artillery (subgroup aerial).

During fire the wireless fighting stations of the subgroups are each to be occupied by an antennen-offizier (mast officer), who must be an artillery officer. This officer is responsible for the efficiency of the station, the quick and correct transmission of the wireless messages, and the correct laying out of the ground signals. (See par. 3.)

Should telephone communication break down, he must see that the observations are passed on by signals (flags, lamps), or by runners and mounted orderlies. Before firing begins it must be ascertained that these communications are ready.

The firing will best be directed from the wireless station.

2. *Call signals.*—Every flight is allotted wireless call signals for its receiving stations, and the observer calls up with them at the beginning of each message. These call signals consist of several letters; sometimes they also include figures for purposes of concealment.

3. *Ground signals.*—For signaling from the ground to the aeroplane, ground signals (strips of cloth) are laid out at the subgroup stations. They have the disadvantage that the aeroplane, in order to see them, must fly near the station in question. Thus in those cases in which observations of fire makes distant

and high flying necessary, time is lost, especially in strong winds. (For the meaning of ground signals, see Appendix 1.)

4. *Telephone communications.*—The following direct telephone communications are necessary:

(*a*) From the aerodrome to the artillery commander or artillery group commander.

(*b*) From the wireless fighting stations to the battery commander of the firing battery.

(*c*) From the artillery commander of the subgroup to the wireless fighting stations.

(*d*) In addition, communication between the wireless stations themselves is desirable.

The construction of these communications is a matter for the telephone troops or for the artillery. Their faultless working is the primary condition of success when firing with aerial observation.

5. *Aviation intelligence officer.*—On days specially suitable for aeroplane registration it may be advisable to despatch an aviation intelligence officer in a motor car to the artillery commander or commander of the heavy artillery.

B. ARTILLERY DUTIES.

1. *Duties of the artillery commander.*—The artillery commander in each case allots the aeroplanes to the subgroups in accordance with tactical requirements. The choice of the observer is left to the flight commander. Under present conditions only one aeroplane at a time can use wireless for a subgroup, as each of these has only one aerial at its disposal.

In cases where subgroups have very narrow sectors and are situated close together, training can and must reach such a pitch that ranging by aeroplane can take place simultaneously in neighboring subgroups, without it being necessary for the subgroups to make previous arrangements with each other.

2. *Duties of the artillery subgroup commander.*—Shoots arranged by the superior artillery commanders are the general rule, as it is only in that way that the wishes of the higher command can be made effective, especially as regards systematic counter-battery work. The artillery subgroup commander arranges the shoot by issuing instructions. These instructions should, when the target is a difficult one, be sent out in good time, if possible the day before; it must, however, also be pos-

sible to carry out orders to fire with aeroplane observation at short notice. This is especially important.

The choice of targets may only in exceptional cases be left to the observer, and only within limits previously arranged. This does not mean that he should not report fleeting targets, the immediate engagement of which seems to him of importance. The decision and order to engage such targets is, however, a matter for the artillery commander, or the commander of the troops. For the engagement of such targets, batteries may be detailed to be in readiness to open fire immediately on receipt of a wireless call.

The artillery subgroup commander's orders must state:

(*a*) To whom the observer is to be allotted.

(*b*) The targets which are to be observed; these will best be described by reference to a photograph or, over the telephone, by reference to a map.

(*c*) A consecutive list of targets to be engaged, or an agreement that the choice will be left to the observer according to what he can see best, that is, if more than one target is to be engaged during the flight.

(*d*) The order in which batteries are to take part, and the distribution of targets to these batteries.

(*e*) Any special arrangements regarding sequence of fire, ammunition, and nature of fuze.

These orders must go simultaneously to the battery and to the flight.

The time to open fire will be ordered by the artillery subgroup commander, and depends on weather and light conditions. Everyone must be informed in good time of any change in this time.

3. *Fire control.*—The battery commander (compare IV, A. 1) controls the fire of his battery. The observer only sends down his observations. It must be clearly understood by all artillerymen and aeroplane observers that registration with aeroplane observation is to be carried out exactly in accordance with the principles of registration with ground observation.

The method of fire adopted by the battery commander should therefore be in accordance with the gunnery regulations.

Batteries with guns which shoot differently must take care that any known plus or minus corrections for the various guns are made before ranging begins, and that the mean point of impact for each gun is close to the target. Only when this has been done will it be possible to change to fire for effect.

It must be the battery commander's aim to get his battery ranged in as short a time as possible. Every effort should be made to place the first round as close to the target as possible, or at least on ground where it can be seen. This can be facilitated by previously firing rounds to test the error of the day. The battery (four guns if possible) must fire as quickly as considerations of material and good laying permit. Only in this way will the services of an observer in a flight of two to three hours be fully utilized.

It is an essential condition for the success of a shoot that every round which is to be observed separately by the observer is only fired when he calls for it, and that the battery fires immediately on receipt of the signal "Fire!" The battery commander must know that the observer can not keep the target continually in view, and that the moment when "Fire" is asked for is the most favorable moment for observation. With regard to fire for effect, compare C., 8 (c). As a rule fire for effect, with sufficient ammunition, must immediately follow registration. The order to cease observing is not given by the observer, but by the battery commander, by laying out the ground signal (see Appendix 1).

C. NECESSARY QUALIFICATIONS AND DUTIES OF THE ARTILLERY AEROPLANE OBSERVER.

1. *General knowledge of artillery.*—For the artillery aeroplane observer the principal thing is to be able to see correctly. For this he requires natural aptitude and much practice. Only a limited general knowledge of artillery is necessary. He must, however, have a knowledge of the artillery's general method of fire. He must, too, be acquainted with the zones of dispersion of the various guns (100 per cent zones), the different kinds of ammunition, the possibilities of observing them, and the times of flight of the projectiles (see Appendix 2). It is not absolutely necessary that the observer should be an artillery officer.

2. *Knowledge of the ground.*—The observer must know accurately, as a result of his own reconnaissance, the ground in which the target lies, and, if possible, have taken photographs of it himself. He must have an exact idea of the targets and of their composition and surroundings.

3. *Knowledge of the position and nature of our own batteries and of the wireless fighting stations.*—The observer must keep himself up to date in his knowledge of the organization of the

artillery of his sector, the position of our own batteries, the caliber and number of guns in the batteries, and the positions of the wireless fighting stations.

4. *Conferences before and after shoots.*—A personal interview with the battery commander is not possible before every shoot on a battle front and is usually unnecessary. The order of the artillery commander must therefore contain everything necessary for carrying out such shoots. On the other hand, a consultation over the telephone is always necessary after these shoots in order to complete the general picture and to gain experience.

5. *Notifying the battery commander and the wireless fighting stations.*—The artillery commanders of the subgroups in question, the battery commanders, the wireless fighting stations, and the antiaircraft sections must be notified when a machine leaves the ground.

6. *Zone and height of flight.*—The zone and height of flight are matters for the observer. He must fly in such a manner as to be able to carry out his instructions, and must bear the following in mind:

(*a*) The higher and the farther away he flies, the more uncertain becomes communication with the battery that is firing, and the best observation becomes worthless if communication breaks down. This applies principally to ground signals, but it is also true for communication by wireless.

(*b*) Errors during observation will be most easily avoided if the observer flies approximately over the line of fire.

(*c*) In order not to disturb ranging by wireless in neighboring sectors, the observer must fly within a limited area during observation.

7. *Protective aeroplanes and protection by antiaircraft guns.*—Protection by means of special aircraft is necessary, when attacks by enemy aeroplanes are to be expected. Antiaircraft-gun protection is desirable. Warning rounds from the antiaircraft guns against the enemy's aeroplanes are of great value.

8. *Method of observing fire—(a) Indication of target.*—When a target has to be described from the aeroplane (see IV, B. 2), it can be done:

1. By means of the map squares or battery numbers in the artillery map, or

2. By means of the target's position relative to a reference point (see Appendix 1).

Wireless "in clear" is only to be used in the most exceptional cases.

(b) *Registration and battery fire.*—Rounds with percussion fuze are the general rule. It is important for the very first rounds, if possible, to be seen by the observer. Should single rounds be difficult to see, then ranging will be done by section salvos or battery salvos. This will be ordered beforehand (see B. 2 e), but can also be asked for by the observer during the flight.

The method of signaling the rounds in ordinary fire is with correction by deflection and by short or over (+, —, r, l.) (see Appendix 1). The observer reports first the correction for deflection and then for short or over. The amount of the short or over correction is only to be given in the case of the first few rounds observed. The supposition that quicker results would be obtained by giving the correction in meters sent by the aeroplane to the guns direct than by orthodox ranging by bracket and battery fire has proved to be wrong. The constant zone of dispersion of our guns makes it necessary that the well-founded principles of our gunnery regulations should always be adhered to. During ranging and battery fire all rounds are to be observed and reported by the observer one by one.

When ranging special guns, the method of reporting results of rounds given in Appendix 1, No. 4 (b), may be used.

(c) *Fire for effect.*—The opening of fire for effect is decided by the battery commander (ground signals, see Appendix 1). From then onward the battery fires without being asked to do so by the observer; the latter should only report now and again the fall of a number of consecutive rounds (about 6 to 12). If some of the rounds are noticeably short or over, or fall very much to a flank, then the observer again asks for single rounds and again corrects for each round.

It is desirable that important cases of fire for effect should be observed to the finish, as the error of the day often causes considerable changes in trajectory in quite a short time, making all shooting worthless unless these changes are observed and reported. As, however, it is not always possible for the aeroplane to fly so long, and as one flight must often be used for several consecutive shoots, one must often be satisfied with observing only a part of the fire for effect. In such a case the fire for

effect can occasionally be continued with advantage by other means of observation (captive balloon, survey sections), if the latter have also been observing since the beginning of the shoot. It is a matter of principle that they may not, during registration by aeroplane, take part in reporting results of rounds.

(*d*) *Photographing after fire.*—After fire for effect a photograph of the target is to be taken; that is, if the vicinity of the target has not been too badly shot about by previous bombardments, and if it is supposed, from the amount of ammunition used, that the results will be seen on the photographs.

(*e*) *Ranging several batteries.*—Ranging several batteries simultaneously by one aeroplane is forbidden, as this generally leads to errors and consequently to waste of ammunition. On the other hand, it is simply a question of time and practice, and of the artillery and aeroplanes working together well, for an aeroplane to range several batteries on different targets one after the other.

V. Training at the Front.

Every artillery shoot must, as far as possible, especially on quiet fronts, be used for training purposes. Ranging purely for training purposes can usefully be carried out with quite a small expenditure of ammunition.

VI. Trench Mortar Shoots.

Aeroplane observation for trench mortars can be carried out in the same way as artillery registration, and the above directions will still hold good.

APPENDIX 1.

I. CODE SIGNALS.

1. Instructions for the use of wireless:

(*a*) Every wireless message will be transmitted on the minimum power necessary for communication. The speed of "sending" will be as quick as possible.

(*b*) The following procedure will be used when establishing wireless communication:

(1) Call. Station call of receiver from station call of sender.

(2) Message.

(3) "End of message" or "change over" signal (Umschaltezeichen).

(*c*) After communication has been established the following procedure will be adopted:

(1) Station call of the receiving station.

(2) Message.

(3) Station call of the sending station or "change over" signal.

(*d*) A wireless message, if of considerable length, will be preceded and followed by a "break" signal.

(*e*) All wireless stations and aeroplanes are allotted wireless calls of two letters each.

(*f*) These wireless calls will be so chosen that they do not coincide with any abbreviations under paragraph 2.

2. Abbreviations: [1]

(*a*) WIRELESS SIGNALS.

Abbreviation.	German.	English equivalent.
S	Schuss	Round (shot).
SA	Salve	Salvo.
EF	Einzelfeuer	Single rounds.
Sz	Ist geschossen worden?	Has battery fired?
NS	Es wurde nicht geschossen	No firing has taken place.
FF	Feuerbereit	Ready to fire.
DD	Schiessen beendet	End of shoot (for intercommunication between two stations this means: The station will close down).
OU	Beobachtung unmöglich	Observation impossible.
WBS	Welche batterie steht zur verfügung?	Which battery is at my disposal?

(*b*) SIGNALS FOR RANGING.

Z	Ziel	Target.
ZM	Zielmitte	Center of target.
ZR	Ziel rechts	Right of target.
ZL	Ziel links	Left of target.
W	Weit	Over.
K	Kurz	Short.
R	Rechts	Right.
L	Links	Left.
TR	Treffer	Target, hit.
NZ	Vorschlag zum zielwechsel	Proposal for change of target.
NO	Nicht beobachtet	Not observed.
FR	Fraglich	Doubtful.

(*c*) DESCRIPTION OF TARGETS.

IM	Infanterie in marschkolonne	Infantry in column of route.
IV	Infanterie in versammlung	Infantry concentrating.
AM	Artillerie in marschkolonne	Artillery in column of route.
AF	Artillerie feuernd	Artillery in action.
MW	Marschkolonne aller waffen	Column of all arms on the march.
BV	Bagagen in versammlung	A collection of transport.
AT	Ausladung von truppen	Troops detraining.
EV	Eisenbahnverkehr	Railway traffic.

[1] The abbreviations given here are for general use. If additional ones are needed, they must be arranged beforehand.

(*d*) PHYSICAL FEATURES.

Abbreviation.	German.	English equivalent.
GB	Graben	Trench.
PT	Punkt	Point.
ED	Eisenbahndamm	Railway embankment.
WD	Wald	Wood.
STR	Strasse	Road.

(*e*) GENERAL ABBREVIATIONS.

PA	Planquadrat	Map square.
NH	Fliege nach Flughafen	Am coming in.
MR	Motorstörung	Engine trouble.
SOS	Muss notlanden	Must land.
WO	Wolken	Clouds.
DU	Dunst	Mist.
NL	Nördlich	To the North.
SL	Südlich	To the South.
OL	Östlich	To the East.
WL	Westlich	To the West.

(*f*) ABBREVIATIONS FOR WIRELESS COMMUNICATION.

UM, UM.	Umschaltezeichen	"Change over" signal.
VE	Verstanden	Understood.
NV[1]	Nicht verstanden	Not understood.
US	Störungen im Funkenbetrieb	Wireless is being jammed.
BP	Bleibe auf Empfang	I am expecting your message.
AS	Warten	Wait (Message will be continued immediately).
WA (5)	Warten	Wait! I will call again in five minutes time.
HH	Hauptwelle	Principal wave length.
NN	Nebelwelle	Wave length for mist.
MG	Mehr Energie	More power.
WG	Weniger Energie	Less power.
NF	Hier liegt kein Funkspruch vor	Nothing further.
FÖ	Funkspruch gelöst	Message deciphered.
FS	Hier fremder Störer	There is an enemy jamming station here.
WH	Wiederholen	Repeat.
WPG	Wie ist dort der Empfang?	How are you receiving my signal.
OS	Das Empfangene ist ohne Sinn	Message received from you does not make sense.
CHI	Chiffrierter Funkspruch	Cipher message.
ZIF	Chiffrierte Stationsnachricht	Message in wireless service cipher.
AR	Schlusszeichen	End of message.
	Irrungszeichen	At least 10 dots in succession=erase.

[1] Given as MV in the original, but this is apparently a misprint.—G. S. I.

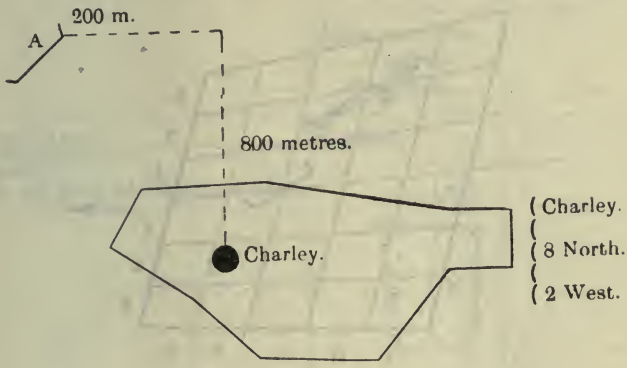
II. GROUND SIGNALS.

The ground signals for signaling from the ground to aeroplanes consist of from one to three variously placed strips of cloth (each 3 to 4 meters long, usually white, but red when snow is on the ground).

No of Ground Signal	Form	Meaning	Remarks
1		Understood	
2		Battery is ready to fire.	If signal is taken away this means that the observation is ended
3		Battery is for the moment not ready to fire.	
4		Not understood repeat message	
5		Yes	
6		No	
7		Battery is changing target as requested	
8		Battery is now going to fire for-effect	
9		Battery is going to fire single rounds again.	

III. METHODS OF INDICATING TARGETS.

(*a*) Indication by means of map squares or battery numbers.
(*b*) Indication by means of a given reference point.



IV. METHOD OF SIGNALING THE RESULTS OF A SHOOT.

(*a*) Reporting the burst according to lateral situation and range.

Abbreviation.	English equivalent.	Remarks.
L	Left of the line battery—target	Lateral corrections are given in figures so long as the bursts are outside the target.
R	Right of the line battery—target.	
Z	Center of target.	
ZL	In target, to the left.	
ZR	In target, to the right.	
W	Over, i. e., behind target.	Corrections in range are given in figures only for the first few rounds.
K	Short, i. e., in front of target.	

Examples:

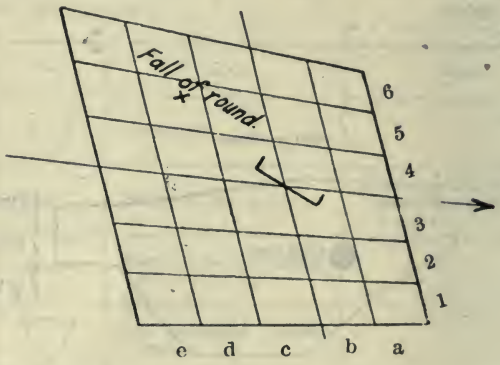
Burst 250 meters to right of target and 450 meters in front of it. Message: R 3 K 5.

Burst 100 meters to right, about 50 meters in front of target. Message: R 1 K.

Burst right side of target, about 50 meters over. Message: ZRW.

Burst in center of target, direct hit. Message: ZMTR.

(*b*) When ranging special guns it may be preferable to take a photograph of the target or, in exceptional cases, a map, and to mark this as follows:



The bursts will be signaled according to the squares. Every shot will be marked on the photograph. This will form a diagram of the rounds near the target and will in many cases replace the usual photograph normally taken subsequently.

EXTRACT FROM APPENDIX 2.

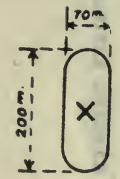
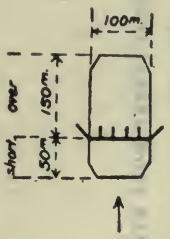
1. This appendix consists of a diagram showing on the $\frac{1}{25000}$ scale the 100 per cent zones of the following guns and howitzers at various ranges and with various charges:

15 cm. heavy field howitzer ('02 and '13).

21 cm. mortar.

10 cm. gun ('04).

2. The following is an example taken from this table:

	15 cm. heavy field howitzer ('02 and '13).	
	Range, 7,000 meters.	
	Sixth charge.	
Time of flight	30 seconds.	
100 per cent zones		
Scale $\frac{1}{25000}$		
A. For single gun firing at a single point (x)		
B. For a battery firing against a hostile battery with a frontage of 100 meters		

APPENDIX 3.

LIGHT SIGNALS FROM AEROPLANES WHEN RANGING ARTILLERY.

● = 1 Red Ball.

○ = 1 White Ball.

◍ ● = 1 Green—Red Ball.

✡ = 1 White Star.

(The burst takes place some time after the shot has left the signal pistol.)

The meanings of the signals are:

= Request for a round, or for a salvo to be fired.

= Short (in front of target) (—).

= Over (behind target) (+).

and = On the target (±), or with a salvo "short and over" (— and +)

= Over, and to left.

and = Over, and to right.

Always give the lateral correction first, then the plus or minus correction.

In salvos of more than two rounds, a white light signal will be given for each single round over and one red light signal for all the rounds falling short.

PART 6.

COMMUNICATION BETWEEN INFANTRY AND AEROPLANES OR CAPTIVE BALLOONS.

(Issued by the Chief of the General Staff of the Field Army.)

I. INFANTRY AEROPLANES.

1. IMPORTANCE OF THE INFANTRY AEROPLANE SERVICE.

It is of the greatest importance for commanders and the artillery to have constant information, in the course of a battle, as to the progress of the infantry fighting, the position of the foremost infantry lines, and any of the enemy's measures which may have been detected.

In consequence of the increased effectiveness of artillery fire, transmission of information from the front line to the rear, in spite of the increase of and improvements in the means of ground communication, is becoming more and more difficult. For this reason the infantry, when heavily engaged, is often unable to obtain the requisite effective support from the higher command and the artillery, ground which has been gained with difficulty has been lost again, and the enemy's successes are liable to acquire a dangerous extension.

In many cases the infantry aeroplane (contact patrol) can render valuable services to the infantry in this respect. Flying at a low altitude, the airman is able to define with great accuracy, on the maps and by photography, the situation of the front lines as revealed to him by the signals of the troops, and can also, by means of preconcerted signs and signals (see Appendix), transmit reports from the infantry, and the results of his observation of the enemy's movements quickly and safely to the rear. Proper cooperation between infantry aeroplanes and the troops will thus

provide the infantry with an additional means of reconnaissance and communication.

2. DUTIES OF THE INFANTRY AEROPLANE.

(*a*) *Determination of the position of our own front line.*—The main duty of an infantry aeroplane, in every flight that is undertaken, is to determine and keep under observation the position of the front line. In any case communication must be established with the infantry by means of signals. Even if the front line has undergone no modifications, the consciousness of being in communication with the aeroplane strengthens the morale of the infantry.

(*b*) *Transmission of tactical reports from the front line and from battalion and regimental headquarters to the rear.*—The heavier the fighting, whether in attack or defense, the greater becomes the dependence of the infantry upon the aeroplane for the transmission of its reports. By means of the arrangements for communicating with the infantry, the infantry aeroplane is able to transmit to the rear, in the shortest possible time, all reports of special importance as to the course of the action and the conditions in the front line. It is particularly important to forward immediately any requests of the infantry for barrage fire.

(*c*) *Tactical reconnaissance in the sphere of the infantry action.*—Thorough familiarity with all details of his sector enables the infantry airman, in addition to his other duties, to carry out very detailed tactical reconnaissance. From observation of the artillery fire upon the front line with regard to the fall of the rounds and the volume and general direction of the fire, as well as from observation of concentrations, movements, and bringing up of reserves in the enemy's trenches, the object and direction of hostile attacks can be recognized, and, by an immediate report, can be nipped in the bud.

3. EMPLOYMENT AND COMMAND OF INFANTRY AEROPLANES.

On the principal fighting fronts special aeroplanes will be allotted to the infantry divisions as infantry aeroplanes. Their number will depend upon the nature of the fighting and their employment will be determined by the flight commander con-

cerned, who will receive his instructions from divisional headquarters.

It may be found necessary, in order to enable the infantry aeroplanes to carry out their duties even in the face of hostile aerial activity, to assign special aircraft for their protection. Applications in this respect should be made to the commander of the aviation troops or to the wing commander.

4. MEANS OF COMMUNICATION.

A. COMMUNICATION FROM THE GROUND TO THE AEROPLANE.

(*a*) *Cloth signals.*—These cloths are colored white on one side and dark on the other (for use in snowy weather); those used at battle headquarters are 2 feet 7 inches by 8 feet 2 inches, and those employed in the front line 2 feet 7 inches by 3 feet 3 inches. It is advisable to stiffen the narrow sides by wooden battens and to keep the cloths in cases as a protection against dirt.

By placing the cloth signals, stretched to their fullest extent, about 55 yards apart, especially at salients and reentrants of the front line, its outline can be defined. To avoid attracting the enemy's attention they must be displayed from the slope of the trench which faces away from the enemy.

They can be used in certain combinations to convey tactical information. (See Appendix.)

As against the disadvantages arising out of the difficulty of displaying the cloths under hostile fire and of the possibility of confusion being caused by their nonremoval must be set the fact that they are easily recognized from an aeroplane, can be unmistakably reproduced in a photograph, and, when once extended, obviate the necessity for continuous observation on the part of the aeroplane.

(*b*) *Signal lamps.*—Signal lamps (infantry signaling apparatus and special aeroplane flash lamps) are used for sending certin flashlight signals to the aeroplane.

Much practice is required for their operation; it is no simple matter for the aeroplane, when hampered by difficult flying conditions and the incidents of the battle, to take the signals so sent. This means of communication is, therefore, not so reliable; moreover, the messages can not be reproduced photographically.

(*c*) *Flares.*—The front line can be outlined by means of white or red magnesium torches or flares. The flares or torches must

be lighted at the bottom of the trench or in shell craters, if possible against a dark background and screened from the enemy. If much smoke is produced, they will attract the attention of the enemy, and must. therefore, only be used exceptionally by the troops in certain circumstances (attack). In the absence of smoke, they are difficult to see from an aeroplane, and can not be photographed.

When used they must be arranged with a certain amount of regularity (groups of 2 or 3 flares or torches, distance between the groups 55 to 110 yards).

Signaling from the front line must be confined to the display of cloth signals, flashes by signal lamps, and the use of flares.

Cloth signals (see Appendix) and Morse signals (see Appendix) on the signal lamp can only be used for the conveyance of information from points situated farther in rear (from the company commander upward).

B. Communication from the Aeroplane to the Ground.

The infantry aeroplane is distinguished by long black, white, and red pennants at the outer extremities of the lower plane and flies at a lower altitude than other aircraft. The infantry aeroplane possesses the following means of communication with the ground:

(*a*) *Light-pistol cartridges.*—To enable itself to be identified by the divisions to which it is allotted as their infantry aeroplane, and as a request to them to display their cloths, the aeroplane will discharge colored light signals when near the front line (see Appendix).

Atmospheric conditions and the position of the sun may render it difficult to recognize and distinguish between the different colors; repeated signals, moreover, can not be made, as but few cartridges can be carried.

(*b*) *Machine-gun fire.*—Failing any other means of attracting the attention of the troops, short bursts of machine-gun fire can be delivered; in the same way several series of rounds from the machine gun have proved a useful method of giving the "understood" signal or the "call" signal of units.

There is danger of such signals being misinterpreted and of the aeroplane running short of ammunition if engaged by an opponent.

(*c*) *Signal lamps.*—Infantry aeroplanes are equipped with signal lamps to enable them to give the "understood" signal

and to repeat Morse messages sent from the ground. These lamps can also be used to transmit reports received from below to such command posts in rear as are unprovided with wireless stations and at which it is inadvisable to drop the report.

(*d*) *Wireless apparatus.*—Each division has a wireless receiving station for the receipt of urgent messages requiring instant action; the infantry aeroplane must report to this station, using certain wave lengths and the preconcerted "call" signal. Demands for barrage fire, in particular, must be transmitted by wireless. It is the duty of divisional headquarters to cause the necessary telephone lines to be constructed, to keep them disengaged while the infantry flight is in progress, and to detail a skilled operator to work the telephone at the wireless station in order that these demands may be transmitted, without any delay, to the proper quarters.

(*e*) *Dropping reports.*—As reports which are dropped by means of the "Rauchmeldepatrone" (smoke indicator) very rarely fall quite close to the command post concerned, it is advisable only to drop them in those places where there is a certainty that the enemy's fire will not prevent a search for the reports. In any case a report should be repeated by telephone as soon as the aeroplane has landed.

5. METHOD OF CARRYING OUT THE DUTIES OF INFANTRY AEROPLANES.

General observations.—The infantry is confronted by the twofold difficulty of identifying immediately, out of the large number of aircraft visible, its own aeroplane, which usually appears unexpectedly, and of often having to display the necessary signals to the aeroplane in circumstances of the greatest difficulty and under heavy hostile fire.

Good will, vigilance, consciousness on the part of the troops that the aeroplane always comes on their service alone and for their advantage, and, if necessary, the issue of drastic orders and the display of severity by commanders, will enable many imaginary difficulties to be surmounted.

The airman, by complete disregard of personal danger, by flying at a very low height and in bad weather, must prove to the troops that they can rely on him in their difficulties. Where confidence is mutual excellent results will be obtained.

MEASURES TO BE TAKEN PREVIOUS TO ESTABLISHING COMMUNICATION.

TROOPS.

1. Certain observers will be posted at all points where signals are to be made, to keep aircraft under constant observation.

2. The signaling apparatus is always to be kept in readiness by the operators.

AIRMEN.

1. Previous to starting, the observer will be informed by the general staff officer of the division as to the situation in the front line.

2. He will communicate the time of his intended departure to the divisional wireless station.

3. It may occasionally be advisable to inform the troops by wireless or by telephone.

THE PROCESS OF ESTABLISHING COMMUNICATION.

1. As soon as the observers recognize an infantry aeroplane, they will keep a sharp lookout for the anticipated light signals.

1. The aeroplane will appear at such a height as, in view of weather and other circumstances, will enable the troops to identify it with certainty (generally speaking, between 550 and 1,100 yards). It can be recognized by long pennants at both ends of the lower planes. Unless the airman disposes of other means of attracting attention by sound, he can do so by means of short bursts of machine-gun fire.

2. As soon as the call signal of the division is recognized, the troops in front line, company commanders, battalion and regimental headquarters, will display the cloths, or report by flash lamp, flares, or cloths, as to the tactical situation.

In signaling with the flash lamp it must be remembered

2. To signify its desire to get into communication with the —th division, the aeroplane will discharge the light signal, forming the call signal of the particular division.

that the aeroplane will devote its attention, first of all, to the front line and company commanders, then to battalion headquarters, and, last of all, to regimental headquarters.

3. The signals will be displayed or repeated until the aeroplane has given the "understood" signal or has obviously departed.

4. Signaling is completed, but the aeroplane will be carefully observed as long as it is in sight.

3. The airman will photograph the front line and its signals. Should circumstances require a sketch of the front line to be brought back at once, the airman will draw it on a section of a large-scale map, or on a photograph. If he happens to detect a remunerative target, he should report it by wireless, giving the map square or number. It is not his duty to observe fire.

4. When the airman has received all the signals, he will give the "understood" signal by repeating the signal given on the ground, by flashing the "understood" signal with the addition of the sector letter, or by light-pistol signals. Urgent reports are to be dropped at headquarters or sent by wireless. They should be sent in the following order: Front line, company commanders, battalion headquarters and regimental headquarters, beginning from the right of each battle sector.

Signals made with the flash lamp are to be repeated until the "understood" signal is given from below.

It is most important to forward at once requests for barrage fire.

5. If the troops should see that, owing to its being involved in an air fight, the aeroplane is unable to receive the signal or that the aeroplane is withdrawing temporarily but unmistakably, the signals are to be taken down and not again displayed till the aeroplane again asks for them.

5. The result of the flight is invariably to be dropped at divisional headquarters or regimental battle headquarters, as the case may be. The report will be supplemented by telephone immediately after landing. Photographs are to be sent on to the regiments concerned as soon as possible. It will be advisable at times for the aeroplane to land temporarily at a special landing place near divisional headquarters, in order to complete verbally the report which has been transmitted by wireless or flash lamp.

6. TRAINING OF THE TROOPS.

The training must conform to the regulations. Arbitrary modifications are forbidden, as they lead to confusion and, possibly, disaster to the troops.

Officers of all ranks must make every effort to insure that troops are thoroughly trained in this most important duty.

It must be explained to the troops that their fear of hostile aeroplanes is exaggerated; that the visual signals and individual soldiers can not be seen from aeroplanes at a great height; and that the light of the signal lamps is only visible to the aeroplane with which they are in communication. Every officer, noncommissioned officer, and man must be sufficiently acquainted with the regulations to enable him to act independently.

Officers of the flying troops who have been trained as infantry airmen should, as far as possible, be detailed to carry out this training.

Each method of signaling will be practiced as a drill.

The men must be regularly drilled in displaying the cloths, lighting the signal flares, and reading light signals and flashes from the aeroplane, under service conditions, as it is by no means easy to display the cloths and receive the signals under fire.

The men operating the signal lamps must be taught, above all else, to signal clearly and distinctly, and not too hurriedly. They must be taught to follow the movements of the aeroplane with the lamp, and to continue the repetition of the signals until the aeroplane gives the "understood" signal or repeats the "call" signal.

Individual training must be followed by regimental training under war conditions, in which aeroplanes should take part.

To make the training more realistic, trenches must be available where the men can operate the appliances, wearing their field service kit and equipment, and in the posture they would be forced to adopt in actual fighting. The aeroplanes taking part in the training must, as they would do in reality, only fly over the position for a short time, and withdraw temporarily, as if owing to prevailing wind conditions and the exigencies of aerial warfare.

II. Captive Balloons.

Captive balloons may be assigned to divisions for important operations, in which, as "infantry balloons" they can, to a limited extent, replace or supplement the infantry aeroplane.

Their employment depends largely on weather conditions (storm, fog).

The infantry balloon carries a conical pennant on the basket, and accepts signals as long as the pennant is flying.

The signal apparatus is used for communication from the ground to the balloon, and vice versa, but it must be borne in mind that if the basket is very unsteady many light signals will be missed. At night the balloon works like an ordinary signal station, and must frequently send out flashes to facilitate "aiming" in its direction. The signals to be made with the signal apparatus are identical with those laid down for infantry aeroplanes.

The balloon observer reports by telephone to the different battle headquarters. The report should be supplemented later by a sketch.

Continual practices between balloons and the front lines are necessary; the principles of training laid down in Section I. paragraph 6, hold good with the necessary modifications.

Signals to be used in communication between infantry and aeroplanes.

A.—FROM INFANTRY TO AEROPLANE.

No.	Message.	Morse signals by signal lamp, or wireless.	Cloth signal.	Light signal (signal shots).	Remarks.
1	Foremost infantry line	Light shown for 20 seconds		White or red light.	The white cloth signals are spread out taut about 55 yards apart on the front edge of the trench if possible.
2	Here is a regimental battle headquarters	By special arrangement, e. g., the regimental No., or regimental No. with letters added.			In heavy snow. Only to be shown if the position of battle headquarters has been changed.
3	Here is a battalion battle headquarters				
4	We hold the line	Light shown for 20 seconds			This signal must always be made to the aeroplane even if there is no change.
5	We are about to advance (ready to attack)	M A — — • —			It also means "lift artillery fire for our own attack."
6	Enemy is preparing to attack	B — • • •			It also means "enemy is attacking."
7	Barrage fire	S • • •		Only to be displayed at command posts of company commanders and upward.	It also means "request annihilating fire on the enemy trenches."
8	Barrage fire nearer our own line	F N • • — • — •			It also means "artillery is firing on our trenches."

Signals to be used in communication between infantry and aeroplanes—Continued.

A.—FROM INFANTRY TO AEROPLANE—Continued.

No.	Message.	Morse signals by signal lamp, or wireless.	Cloth signal.	Light signal (signal shots).	Remarks.
9	Lift artillery fire	F . . — .			Only to be used in cases of extreme urgency.
10	Support necessary	U . . —			
11a	Enemy has broken through on our right	R . — .			
11b	Enemy has broken through on our left	L . — . .			
11c	Enemy has broken through in our center	M — —			
11d	Enemy has broken through in our center and on our right.	M R — — . — .			
11e	Enemy has broken through in our center and on our left.	L M . — . . — —			
11f	Enemy has broken through on our right and left (center holding on).	R L . — . . — . .			
11g	Front line lost	O — — —			
12	Counter attack has failed	G I — — . . .			
13	Hostile attack repulsed	A B . — — . . .			
14	Understood	Light shown for 5 seconds.			

1	I want to get into communication with the—				
	First Division (from the right)			One white and one red light.	
	Second Division (from the right)			One green and red double star.	If the light signal ammunition is bad, one green and one red light.
	Third Division (from the right)			Two white and one red light.	
	Fourth Division (from the right)			Two green and red double stars.	If the light signal ammunition is bad, one green and one red light.
2	Understood	Light shown for 5 seconds, or repetition of the signal received from the ground.		Two red lights.	
3	Barrage fire	S . . . (adding the number of the sector).			To be repeated until barrage fire is opened.

REMARKS.

1. If the "call" signal (B1) for a division is given, small cloth signals are to be put up (A1) in the front line; messages are to be sent from command posts with large cloth signals (A2—14).
2. All signals should be repeated or left in position till the "understood" signal (B2) is given, or the aeroplane withdraws.
3. It is advisable when giving the signal "understood" in Morse, to preface it always by the prearranged call signal of the unit.
4. Wireless messages "in clear" are not allowed.
5. Dimensions of the small signal cloths are 2 feet 7 inches by 3 feet 3 inches, of the large cloths 2 feet 7 inches by 8 feet 2 inches. They are strengthened on their narrow sides by wooden battens; they should be kept in cases, as a protection against dirt. The cloths are colored white on one side and dark on the other for use in snow.
6. The signals contained in lists A and B are universal. Other signs must only be used by agreement, on each occasion, with the troops in line.

HINTS FOR TRENCH-MORTAR OFFICERS.

Policy.

(*a*) To gain absolute superiority over the enemy in trench mortar activity. To hammer his trenches and "tender spots" within reach whenever opportunity offers, and to hit still harder if the enemy hits back.

(*b*) To remove the enemy's wire systematically and methodically.

(*c*) To be able to act on the defensive, when necessary, by so placing your mortars at night—if not otherwise required—that they will be able to join in the artillery barrage or fire onto our own front line, should it be captured.

Grouping.

You are now grouped under the infantry brigade whose section you cover. The brigadier, through your trench-mortar group commander, will instruct you as to what objectives you will engage from day to day. If you want anything, ask your trench-mortar group commander, and keep on asking. Consult with the other trench-mortar officers of your group and arrange to help one another. Do you arrange your communications so as to facilitate cooperation between yourself, other trench-mortar batteries, and the infantry?

Siting of Trench Mortars.

Continually reconnoiter for new sites for your trench mortars and consult with your group commander when you have found likely places. Consider always the desirability of concentration of fire, of obtaining full advantage of your range, and of easy access to the position.

Make beds and place bed frames in all approved positions. When concentrating many guns, register with only one gun at a time and at as long intervals as times permit; otherwise you will disclose your intentions.

Observation.

It is wasteful to fire without observation; it does no harm to the enemy and only makes him laugh at you. R. A. O. P.'s are always available for your use, and R. A. officers will generally be able to observe for you. A telephone from you to your guns is not always essential; some simple system of visual signaling—such as on a rifle range—can be arranged. In such cases it is often helpful to arrange to signal "North, south, east, or west." Do not complain that you are short of telephone wire and then leave on the ground hundreds of yards of wire obviously out of use.

Information.

You must know all about the hostile trenches opposite you. There is an abundance of information available to you in divisional and corps "summaries," and you can check this and other information obtained by studying the aeroplane photographs to be found at battalion and brigade headquarters. There are innumerable targets to damage and destroy, and you should always display keenness to engage them and to take part in any enterprises being carried out by the infantry or artillery.

Gun Positions and Cover.

Are your gun positions good? Is there proper cover for the gun, ammunition, and detachment? Are the dugouts really strong, and have they got *two* entrances? Have you speaking tubes down to your dugouts? Are your magazines dry?

Gas Precautions.

Do you and your men thoroughly understand the order regarding "gas precautions"? Have you got your proper number of gas masks, box respirators, etc.? Have you got Vermorel sprayers and solution properly stored for them? Are the gas blankets in position at entrances of your dugouts? Do you carry out "gas drill," and do you thoroughly comply with the orders for "Gas alert" period?

Work.

Do your men do a full day's work? If the men are allowed to be lazy, they will only complain when given work to do. Men who are worked hard and regularly, are properly looked after, and who do not see their time and work wasted by want of forethought on the part of their officers are always contented. Men who are contented and who have the knowledge that they are superior to the enemy are always happy.

Turnout and Cleanliness.

Are your men smart and properly turned out, especially when in billets? Are your emplacement, dugouts, guns, and stores all kept thoroughly clean? If your battery is not clean and smart externally, it is a sure sign that it is lazy and dirty internally.

Concealment and Action of the Enemy.

Do you appreciate how easily German trench-mortar emplacements can be seen on aeroplane photos? Do you take precautions that yours are better concealed? Do you construct dummy emplacements to draw fire off you onto unimportant spots? Do you take notice of what our own troops do on being shelled by trench mortars, and do you profit by assuming that the enemy probably does likewise when you shell him?

Noncommissioned Officers.

Your noncommissioned officers should be fully capable of carrying on if you become a casualty; can they, and do they understand your plans and methods?

Rest.

When you are in rest, do you visit your D. A., H. Q., D. T. M. O., and other trench-mortar offices in rest to exchange ideas? Do you provide your men with baths, amusements, change of diet? Do you inspect their clothing and equipment? Do you drill and instruct your men so as to keep them well disciplined and thoroughly up to their work?

Liaison.

Have you got a close liaison with the infantry and artillery, and do you visit company commanders frequently, and also any R. A. observers in your vicinity?

Finally.

Have you got that knowledge of your work which brings confidence to you? Can you answer favorably all the above questions? If not, you must strive till you can. Is your battery better than the batteries on either side of it? If not, why not?

PRELIMINARY NOTES ON THE RECENT OPERATIONS ON THE FRONT OF THE SECOND ARMY.

1. Raids.

The value of raids for purposes of training, identification, and morale was again proved, more particularly when carried out by the troops over the ground they themselves were to attack.

2. Liaison.

(A) ARTILLERY AND INFANTRY.

The principle which was observed of having senior artillery officers for liaison proved good and gave the infantry confidence.

In bombardment each division had either a group or a double group of siege artillery working with it. The work was coordinated by the corps, but the divisional commander had always a direct call upon the group or double group and had a lieutenant colonel, R. G. A., as liaison officer.

Whenever artillery liaison officers are attached to formations they should join some days before the operations begin, so that plans may receive the fullest discussion and coordination; these officers are then able to deal with artillery questions as they arise.

(B) OTHER UNITS.

It is of great importance that information as to which units and formations have been selected for any particular operations should be given out early, so as to enable the brigade and battalion staffs concerned to get into touch with one another and arrangements to be made for liaison between the flanking units of both divisions and brigades.

Arrangements should be made to obtain the distinguishing marks, code names, and signal calls of the division, brigade, and battalion on the flanks.

Wherever possible, meetings should also be arranged before the attack between parties of the officers, noncommissioned officers, and men of flanking battalions of neighboring divisions.

3. Rehearsals of Barrages.

The value of rehearsals was very great. Gaps in the barrage, errors in timing, and also individual guns shooting short were detected and put right. Air photographs helped materially in this and were a great check upon ground observation, especially as to where gaps really were at different stages and what gun was systematically firing short. In corps and divisional practice barrages an overlap was always made to avoid disclosing boundaries and also to practice junctions.

Army practice barrages on the whole front undoubtedly drew the German artillery fire, but machine-gun fire should be included to make them realistic. Care should be taken, however, that the flanks of attack are not clearly indicated by practice barrages.

4. Camouflage.

Articles of camouflage were found to be very inflammable. The strictest precautions against fire should be taken by all battery commanders.

5. Gas and Oil Projectors.

Considerable use was made of projectors both for gas and oil with, it is thought, satisfactory results. The tactics pursued were to shepherd parties of the enemy into woods and leave certain routes free from heavy shelling and then to concentrate with projectors on such places.

6. Machine-Gun Barrages.

(*a*) Machine-gun barrages proved of much value. They require careful coordination with both artillery and infantry and should be practiced beforehand with artillery barrages. The infantry should also know that machine-gun barrages will be employed, so that there is no chance of their being under the impression that hostile machine guns are firing. The machine-gun scheme should be on the simplest lines possible.

(*b*) The range at which the barrage guns fired varied from 2,250 to 2,750 yards, and although at first there was a certain

amount of nervousness as to the accuracy of the fire, all ranks finally testify to the value of the machine-gun barrage and the confidence with which it inspired them.

As the attack progressed the "barrage" guns were moved forward in bounds. Each bound was about 800 yards, and it was found that the move could be accomplished and the guns set up in their new position ready to fire in one hour.

(*c*) Belt filling was done in some companies by hand, but in the majority belt-filling machines were taken forward and set up under cover in shell holes.

(*d*) It is considered essential for each gun in the barrage to have two new barrels for the first 24 hours. The normal life of a barrel is 25,000 rounds, but for overhead fire the barrel is inaccurate after 15,000 rounds.

(*e*) It was found that where machine guns were sent forward with the assaulting waves they almost invariably got knocked out or suffered such losses of personnel as to be practically useless on arrival at the objective.

The best solution with regard to forward guns would seem to be for the sections to follow closely behind the battalion to which they are attached and attain their objective by a series of bounds, previously reconnoitered in each case by the section commander.

(*f*) Prisoners' statements confirm the value of continual harassing fire by day and night during the period immediately before operations take place.

7. Rest.

Owing to the slight chance of the troops obtaining any rest on Y/Z night, since they are either on the move or among batteries in the forward assembly area, it was found advantageous for battalions to arrange to have hours of silence in their camps on Y day.

If the best value is to be obtained from the troops, it is essential that their march to the forward assembly area on Y day or Y/Z night should be only a very short one.

8. Advance of Infantry Under Barrage.

In a few cases in advancing over ground very broken, either in configuration, by mine craters, or by heavy shelling, waves were found rather difficult to handle and had some little diffi-

culty in keeping up with the barrage, and it was found preferable to jump off in small columns and to deploy subsequently under the barrage.

9. Patrols and Consolidation.

(*a*) Patrols from divisions with distant objectives were sent forward with the divisions to which nearer objectives were allotted in order to ascertain and report the latest developments of the battle before the launching of the attack of their own divisions. Good results were obtained from these, but it is considered that full value can not be expected unless the patrols are lightly equipped.

(*b*) It is a principle which must never be ignored that patrols are pushed out after the gaining of the final objective. Even if it is impossible for them to pass through the stationary "protective" barrage at once, they should always be able to do so as soon as this has slackened down to fire on selected points.

In addition to infantry patrols, use was made of special patrols consisting of one officer and four other ranks from the corps cavalry squadrons attached to divisions. These followed the method outlined in O.B./1782/A, dated May 26, 1917, and were despatched with the task of answering certain definite questions; in spite of the disadvantage of working to a limited objective, these were of distinct value and the information obtained by this means was most accurate.

(*c*) Consolidation of the main ridge was intrusted to the troops who had captured it, and all arrangements were made accordingly. The later advance to the Oosttaverne line was made by fresh troops of other divisions.

10. S O S Barrage.

The aeroplane wireless S O S for barrage is a very valuable addition to other methods of calling for S O S.

Protective or S O S barrage after gaining the final objective should be in great depth. In this case a very heavy and deep barrage of 60-pounders and heavy howitzers beyond the 18-pounder barrage was provided, and the counter attack from the Warneton line was absolutely crushed.

11. Transport of Water and Supplies.

Much use was made of pack animals in the advance, and the carrying of water and tools to the troops in front line was effected by this means without difficulty.

In some formations they were used for the issue of rations to units for some days previous to zero. Such rehearsal is most desirable in order to find out animals not handy with pack, or likely to gall, and faulty harness causing galls.

Yukon packs proved most useful for the carrying up of stores, etc. As regards water, it was found that three petrol tins could be carried on one pack, but that training is required in moving in the bent position necessary.

The carrying by each man of two water bottles (one containing water and one containing cold tea) was found to be a very satisfactory arrangement.

12. Salvage.

All parties should carry back salvage when returning from the front area. It should also be regarded as a point of honor that no individual returns empty handed; it is seldom realized how important a total of salvage can be effected by individuals in this way.

13. Sign Boards.

Sign boards having the British name of the trench, etc., printed clearly in block letters and on both sides, and direction boards, giving the way to dressing stations, brigade and battalion headquarters, salvage dumps, prepared previous to the operation, were most useful. (S. S. 135, Sec. IX, par. 4 (vi).)

14. Congestion in the Forward Area.

Salvage, burying, carrying, and other working parties should be withdrawn to their camps well behind the forward area when not actually at work.

The congestion in the forward area caused by such parties is responsible for a large increase in casualties, additional shelling owing to amount of movement, and necessitates extra ration parties or transport and crowding in dugouts of men not employed in defense of the line.

15. Control of Traffic.

(*a*) It was frequently found that officers and other ranks did not pay sufficient regard to the authority of noncommissioned officers in charge of traffic-control posts at important cross junctions. Considerable congestion is likely to result from this lack of discipline, and it rests with A. P. M.'s to insure by personal supervision that their orders are carried into effect.

(*b*) The construction of switches around villages and other places or points which are known or likely to be constantly shelled by the enemy is a matter to which close attention should be given.

16. Tank Lessons.

The general principles of the employment of tanks as an adjunct to the infantry attack require to be carefully studied by all commanders. These, as laid down in S. S. 164, were substantially borne out in the recent operations; no new lessons were learned, but fresh emphasis was laid on the following points:

(*a*) There is still a tendency for groups of infantry to bunch behind tanks and follow them about. This not only results in an increase of casualties, as tanks invariably draw fire, but also in loss of direction and cohesion.

(*b*) There is also a tendency to endeavor to retain tanks to meet possible eventualities; it can not be too strongly impressed upon all infantry commanders that when once the infantry are firmly established on their objective, the tanks should be withdrawn.

Further, though tanks can render great assistance to infantry consolidating, their employment on this duty, as long as the enemy's artillery is active, is attended with grave risk and should be reduced to the minimum. The stationary employment of a tank can only be justified in the most exceptional circumstances. (S. S. 164, par. 3 (iii).) On the other hand, several instances occurred where a derelict tank was successfully used to form a strong point. In such cases the infantry should take over the tank from its crew.

(*c*) Pigeons from tanks worked well and could have been put to more extensive practical use had other means of communication failed.

17. The New Organization.

(*a*) The new organization worked very well and completely proved its value. There is nothing to add to S. S. 144, "The normal formation for the attack."

In all training previous to operations the cadres of platoons and sections must be trained as such and kept ready to receive reenforcements.

Amalgamation should be resorted to when it is obvious that the unit will not be brought up to strength before the operations.

(*b*) It was found that carrying parties sent up after the capture of the objective could find their way through the hostile barrage with fewer casualties than those following closely in rear of the assaulting waves.

(*c*) Heavy tools were in nearly all cases carried up by special parties and not on the men of the assaulting waves.

(*d*) There is still a tendency for infantry to rely on artillery fire to deal with counter attacks rather than on the use of their own fire.

OBSERVATION STATIONS.

1. To derive full benefit from the accuracy and rapid fire of modern equipment and to insure effective support to the other arms, correct observation with reference to the objective is of vital importance.

The necessity for accurate fire on all occasions can not be overestimated, and is especially important in trench warfare, where the opposing trenches are often in close proximity to one another.

2. Although it is possible to determine by calculation the line and range required to be given to a gun to hit a target, and although these corrections may have been accurately worked out and applied, yet it is improbable that the maximum effect will be obtained on the target unless the actual fall of the rounds can be observed.

To enable a battery to engage a target effectively, either reliance must be placed on observation from the air or a position must be selected from which the target can be clearly seen and the fire of the battery accurately observed and controlled.

This position is called the "Observation station," and is commonly alluded to as the "O. P."

3. The closer this position is to the target, and the better the view of the ground in its vicinity, the easier it is to determine with accuracy the distance a shell has burst over or short of the target.

To attain this accuracy of observation, it will usually be necessary to select an observation station within 600 yards of the target.

Should it be necessary for any reason to select an observation station which is more distant than this from the target, it must be realized that the same accuracy of observation can not be obtained, even when aided by the best glasses and telescope.

4. In trench warfare it is the target to be dealt with that is the controlling factor in the selection of this position. In every situation there is probably one locality above all others from which the best view of a particular target can be obtained.

The finding of this locality will often necessitate a prolonged and careful reconnaissance, and officers must not be satisfied until they have assured themselves that all ground, buildings, etc., have been thoroughly reconnoitered with this object in view.

With the accurate maps now supplied it should be possible, more or less, to foresee what points are likely to give a good view of a particular locality, and much time can be saved by studying the contours of the map before going out to look for an observation station.

The extent of country included in the reconnaissance should not be restricted to the immediate front allotted to a battery but should cover an extensive area, as it is impossible to be sure of obtaining the best possible view of the whole front or of a particular target (such as a machine-gun emplacement) unless the reconnaissance is carried out thoroughly. This is particularly the case in undulating country.

In a moving battle, when time is the controlling factor, it will generally be found impossible to carry out such an extended reconnaissance, and, therefore, a position that fulfills the immediate requirements may have to be selected.

5. It is impossible to lay down definitely the distance an observation station belonging to a battery should be in rear of the infantry it is supporting.

This distance depends mainly on the shape of the ground.

When the ground is concave in shape, the observation station may be some distance in rear, but the necessity for accurate observation must not be overlooked.

If the ground is convex the observation station may have to be sited in the front-line trench or immediately behind it.

When this is the case it is generally due to the selection of the infantry line having been made without taking into consideration the requirements of good observation for the artillery.

As the position of the observer in the latter case renders him liable to be put out of action by any hostile bombardment of his portion of the front line or to interference caused by the retirement of our infantry, or to capture in the event of a successful attack by the enemy, or at least to have his communications cut, it is imperative in such a situation to provide a second or reserve observation station farther to the rear from which the ground behind the front line is visible, and this station should be maintained ready for occupation in case such an emergency should arise.

If a position can not be found from which the whole of the front is visible, and as accurate fire is essential, the observation must be from a point which gives a clear view of at least one datum point, so that the error of the day may be corrected.

In open warfare it may be necessary to select a position still farther to the rear so as to obtain a more extensive view of the ground over which the fire of any particular battery may be required, and also because it may be impossible to keep up communications with an advanced observation station.

6. Officers must be able to range their batteries at short notice on objectives far to a flank, and must know where the best view of such localities may be obtained.

7. In selecting the position for an observation station the following requirements must be kept in view:

(*a*) It must be suitably sited to carry out the task in hand.

(*b*) It requires to be carefully screened, so as not to be recognized by the enemy.

(*c*) It should, if possible, have a concealed means of approach.

(*d*) It should afford cover and protection to the observing officer and his assistants.

(*e*) It should allow of intercommunication with the infantry.

8. Observation stations may be classified as follows:

(*a*) Permanent.

(*b*) Extemporized.

(*c*) Temporary.

(*a*) A permanent observation station must be strongly constructed and be sufficiently large to accommodate several observers and their assistants.

A covered approach is a matter of vital importance. It must be provided with a dugout capable of resisting at least a 5.9-inch howitzer shell.

It should afford an extended view of the front.

It should not be exposed to fire directed on the infantry front-line system of defenses.

The dust and smoke and the moral effect on the observer, if posted in the infantry line, render observation from it difficult if not impossible.

(*b*) An extemporized observation station is used to carry out a special task, such as the destruction of a machine-gun emplacement or wire cutting.

It should be provided with splinter-proof accommodation for the observer and his assistants. The field of view is of secondary importance.

(*c*) A temporary observation station is used in open warfare when there is insufficient time available to provide artificial cover.

In this case use is made of houses, trees, haystacks, trenches, and shell holes, etc.

9. Every battery must be provided with at least one observation station, for the maintenance and control of which it is responsible. This station must afford a good view of at least one or more datum points.

All observation stations should be made as strong as possible, but the fact that a battery is provided with a strongly constructed post must not deter officers from utilizing the best places available, irrespective of cover, for the observation of any particular task they may be required to carry out.

10. An observer in one observation station may have little chance of seeing more than a limited extent of the ground which his guns can cover.

Moreover, it is often not realized that the principle of concentration of fire can not be put into practice unless batteries are prepared to fire on the whole extent of their arc, however far it may be outside their normal defensive zone.

Arrangements must therefore be made to have a number of observation stations along the front, so that every possible part of the hostile lines is visible from at least one post. A concentration of observation stations at any one point must be avoided as far as is possible.

As it is practically impossible to provide each battery with a sufficient number of stations from which to observe the whole of the ground covered by the arcs of fire of its guns, arrangements must be made to form group O. P. exchanges, and these exchanges must be connected up to the exchanges of neighboring groups.

Such exchanges must be made practically impervious to artillery fire.

By this means it is possible to provide a telephone system that will enable each battery to be ranged on any particular point required, and an observer can direct the fire of any battery within range on to any target in his zone of observation.

This arrangement simplifies the concentration of fire on any point, but, in order to derive full advantage from it and thus inflict the greatest damage possible on the enemy, it is imperative that every officer of the artillery should be capable of sending back observations for any battery, irrespective of its nature.

11. There are several purposes for which an observation station is required, which differ somewhat with the nature of the battery, the task to be undertaken, and the tactical situation. They may be classified as follows:

(A) FIELD GUNS.

The 18-pounder quick-fire battery is usually charged with the direct support of an infantry battalion holding a front. This front is watched by day and often at night by an artillery observer in order that any movement of the enemy by day may be at once seen and dealt with, and signals for support from the infantry responded to at night.

An observation station for this purpose should command, if possible, the whole zone allotted to the battery without being too far back, but it should not be in the front line if it can be avoided. (See par. 5.)

It should afford a view of the ground over which the enemy must attack for at least 200 yards in front of our own front line, and it should be possible to overlook a portion of the ground behind this belt over which the enemy may be expected to move his troops.

If it is near the battalion or company headquarters, the communication with the infantry is facilitated.

(B) FIELD HOWITZERS.

The 4.5 inch howitzer battery is usually responsible for the whole front covered by the field artillery brigade to which it belongs, and, further, it is required to support the brigades on the flanks. It is seldom possible to obtain an observation station with this field of view. Observation from several stations is therefore necessary. The usual custom is for the battery to have a permanent station in some central position and to supplement the observation by utilizing observers in the other observation stations belonging to the brigade and division. This is rendered possible by the provision of O. P. exchanges.

(C) HEAVY HOWITZERS.

The siege battery may be required to fire on any portion of the enemy's lines which the arcs of fire of its guns can cover.

It follows therefore that officers of the siege artillery require an even more extended knowledge of our own and the enemy's

front from the point of view of observation than officers of the field artillery.

Furthermore, the heavier the nature of the artillery the more important it becomes to obtain close and accurate observation of a target.

The provision of suitable O. P. exchanges for the siege artillery is even more important than for the field artillery.

The O. P. exchanges of both field and siege artillery should be connected, so that full advantage may be derived from all O. P.'s. (See par. 10.)

(D) Heavy guns.

The chief rôle of the heavy batteries is the neutralization of hostile guns, and the searching of distant approaches, observation on which is impossible except from the air.

When an aeroplane is not available, this shooting must usually be done from the map, the guns being calibrated from time to time on a datum point.

As heavy batteries are also employed to enfilade trenches, they must be provided with observation stations giving a good view not only of the datum points but also of as much ground in the enemy's front system as possible. These stations must be connected up to the observing post exchanges, as in the case of the siege artillery.

12. In addition, heavy and siege batteries are often required to find observers by day and night to assist the field-survey posts in the spotting of flashes of hostile guns. Such observing stations are often far back and on the highest ground available.

13. An observation station should contain:

(1) A panorama sketch of the view from it.

(2) Orders as to the procedure in case of S. O. S.

(3) Orders as to the procedure in case of a gas attack, particularly instructions as to the use of the telephone.

(4) A diary of what is daily observed on the front, and information which may be of importance to a battery which may have to take over the zone.

This should include the known and suspected positions of trench mortars and machine guns, and localities where the enemy's movements are visible.

When the observation station is behind the reserve line of trenches, an artillery board may be added.

14. The supreme importance of quickly establishing forward observation stations in the event of a successful advance can not be too strongly impressed upon all artillery officers.

It is in such a situation that the greatest advantage may be reaped from the early occupation of advanced observation stations and commanding heights beyond the original hostile front line, which afford direct observation of the terrain occupied by the hostile artillery.

This is especially important in the case of those batteries allotted to the counter-battery groups.

NOTES ON COMMUNICATIONS DURING RECENT OPERATIONS ON THE FRONT OF THE SECOND ARMY (PROVISIONAL).

(Issued by the General Staff.)

1. Preparatory.

(*a*) A considerable number of poled cable routes on permanent poles were used between the open wires and buried cable system and proved their usefulness.

Telephones were withdrawn from in front of brigade headquarters and Fullerphones utilized as far as possible.

(*b*) The R. F. C. were given their own routes and exchanges throughout; they controlled their own traffic and were able to make the best use of these lines to the mutual advantage of all concerned.

(*c*) An army report center was established with direct lines to—

All field survey O. P.'s.
Special army O. P.'s.
Forward kite balloon and K. B. sections.
Army headquarters.
Liaison officers at each corps and division.
Corps heavy artillery headquarters.
R. F. C. and antiaircraft systems.

Much information was received on the direct line from the forward balloon.

(*d*) Buried cables: The gridiron system was adopted where possible, with a cable head in the front line to each attacking brigade sector averaging 20 pairs. Forty pairs are recommended.

One corps buried a complete new system for the artillery, taking the old artillery lines into the command system. The corps allotted all lines, and the results proved this to be the preferable arrangement.

The other corps added to their old system and the allotment of lines was done by the divisions.

A pilot line to all test and junction points is a necessity, and a man who knows the system should remain at each such point to make the connections as ordered by the signal officer i/c of the bury.

(*c*) Both in the case of the infantry and of the artillery the schemes of communication should be drawn up and orders issued by the staff, sufficient time being given to the signal service to enable them to be carried out. Where this principle was adopted the results were good.

2. During the Battle.

(*a*) The approved principles of forward intercommunication in battle worked well. They should not be rigidly applied to all situations, but allow of sufficient elasticity to meet the varying conditions.

(*b*) Cable took the majority of the work back from brigade forward stations. The enemy artillery fire was, generally speaking, weak, and in consequence it was in most cases possible to keep lines through continuously when once established.

The lighter types of cable were found most useful (D. II and D. VII twisted) for the first lines. They are lighter and more portable and are as likely to stand as the heavier types.

(*c*) The power buzzer produced some excellent results, and too much stress can not be laid on the necessity of training personnel with this apparatus.

Amplifiers should not be placed in cable heads or signal offices. Where this was done they were jammed.

(*d*) Visual: The Lucas lamp was used extensively and proved invaluable.

Shutters and flags were used by battalions and companies. They are not of much use to brigade forward stations.

(*e*) Pigeons were not much used, but messages sent off generally arrived in good time. The supplies were good.

(*f*) Green flares were easily seen until the sun rose. During daylight they should be lit in groups, as singly they are most difficult to pick up. Brigade and battalion headquarters signs are of value, and if exposed when called for by the contact patrol effect a great saving of time.

3. After the Battle.

(*a*) Communications after the battle were maintained by the system established during the flight, improved and enlarged until such time as the buried cable system could be pushed forward.

The artillery extended their O. P. lines for necessary registration purposes.

In one corps a special battalion was detailed and trained to bury cable from "cable head" immediately the objectives were secured. This proved very successful and is recommended.

The buried cable system to be adopted should be laid down by the army and should be continuous without thought of boundaries.

(*b*) In one case difficulty was experienced where one division passed through another. It is desirable for both to have their own lines to cable head before the commencement of the battle.

The allotment of lines should be made by A. D. signals of corps, and not by divisions.

(*c*) Where possible it is advisable temporarily to enlarge the area parties. This should be done an appreciable time before operations commence, to enable men to learn thoroughly the system in their area.

(*d*) The advantages of the R. F. C. being provided with their own system of communications were pronounced. The army intelligence report center for the quick dissemination of information by direct lines was of great value.

(*e*) It is desirable to have an officer at cable head to prevent confusion in picking up lines or overcrowding in the cable head dugout.

(*f*) A reserve of light cable as well as the armored squad for the bury when dug must be kept near cable head.

(*g*) The "A" detachment of brigade forward stations went over if anything too early and frequently became involved in the "mopping up." Loss of men and gear resulted.

(*h*) The necessity of placing some distinguishing mark at the entrance to a dugout when brigade forward station has been established. On one occasion our "mopping-up" parties bombed a brigade forward station.

(*i*) Four-line exchanges were made with electric-light sockets, and plugs proved useful at relay posts, for listening-in on all lines.

(*j*) Difficulty was experienced with code and position calls during the battle. Position calls for exchanges and test points work well, but when used for units there is apt to be confusion. Code calls should be used by units after zero whether they are in our trench system or no. Three or more units may use the same headquarters on the same day.

(*k*) Headquarters or formations should move up into their battle headquarters in sufficient time to allow signals to make the necessary corrections, etc., to enable the men to learn the new system before zero day. Where this was not done considerable loss of efficiency was evident.

(*l*) "The urgent operation priority" prefix defeated its own object. All officers sending information consider their messages "urgent operation priority."

(*m*) The special officer named in S. S. 148 ("Forward intercommunication in battle"), Section II, paragraph 3) (*b*), as the officer at the brigade forward office in control of the method of transmission must realize that it is his duty to take the responsibility for marking really important messages, "Priority."

(*n*) With a limited objective it is necessary to push the cable head forward immediately. The artillery may require these wires for registering their batteries on new lines.

(*o*) Sufficient stress is not yet laid on the necessity for despatching an important message in duplicate to increase the chance of its safe arrival. Where possible such messages should be sent by alternative methods; when runners only are employed they should be despatched with the duplicated message at a 100-yards interval.

(*p*) Closer touch is desirable between battalions and the relay system of runner posts organized by brigades. The relay posts should be marked so as to be easily recognizable from a distance; e. g., with a large colored flag by day and with a colored lamp by night. In one instance it was found useful also to mark with small colored flags the shortest route for runners from brigade headquarters to the brigade forward station. Alternative routes should not be marked.

NOTES ON THE USE OF SMOKE.

(Issued by the General Staff.)

Use of Smoke Screens.

Smoke screens may be employed with one or more of the following objects in view:

(*a*) To protect the flanks of assaulting or advancing infantry by preventing observation from enemy observation posts, high ground, and salients, or from ground from which the advance is liable to be enfiladed.

(*b*) By infantry in the attack, to blind hostile machine guns.

(*c*) As a feint to induce the enemy to expend ammunition needlessly or to put down his barrage.

(*d*) As a feint to draw the enemy's attention to a front on which no attack is being made, and thus hold his troops in their trenches and prevent them from going to the assistance of the front attacked.

(*e*) In the case of a smoke cloud used offensively, to simulate gas, with a view to lowering the enemy's morale and forcing him to use his gas mask.

To make this effective gas should occasionally be mixed with smoke in order to drill the enemy into the belief that it is never safe to remain in a smoke cloud without wearing his gas mask.

(*f*) In flat or open country to conceal concentrations of guns and troops, and possibly to screen roads, forming-up places, and lines of advance. To conceal the flashes of a battery which is in view from the enemy's observation posts, and to hamper observation from the air.

Ground and troops can seldom be concealed from hostile aeroplanes or kite balloon observation behind smoke screens, and although they may be concealed in smoke clouds such clouds attract the enemy's fire and are therefore dangerous.

A smoke cloud, however, may be used with success to interfere with any attempt of the enemy to range accurately with aeroplane observation on one of our batteries.

As stated above, smoke tends to attract the enemy's fire. Smoke screens should normally be formed, therefore, at some distance (about 400 yards) from the object to be concealed.

Troops attacking through a smoke screen are very liable to lose direction. This fact should be carefully considered before troops are committed to such an operation.

When smoke is to be liberated on the flank of an assault, care should be taken, by defining permissible wind limits beforehand, that the cloud does not pass across the front of the assaulting troops.

While the use of smoke may conceal the position and movement of our troops from enemy observation, it may also hide them from our contact patrol aeroplanes. This must be considered when determining the nature and extent of smoke screens and careful precautions should be taken to preserve liaison between the infantry and the flying corps.

When the use of a smoke screen in operations is intended, the enemy should be educated to associate such a screen with some object other than the real one, e. g., he may, by means of a practice smoke screen, followed by no action, be led to suppose that the object of the demonstration is to compel him to expend ammunition uselessly.

Smoke-Producing Substances Available and their Normal Uses.

The following means of producing smoke are available:

(*a*) P bombs and No. 27 (white phosphorus) grenades.

(*b*) Single smoke cases, type S.

(*c*) 18-pounder and 4.5-inch howitzer smoke shells.

(*d*) 4-inch Stokes mortar smoke bombs: 13-pounder shell, range 450 yards; 25-pounder shell, range 900 yards.

In addition, experiments are being carried out with smoke generators of various descriptions, and means of producing smoke with burning straw tightly packed in sacks, damp hay, tar barrels, green wood, etc., can be improvised.

P bombs are designed partly as incendiary and partly as smoke-producing articles. They are filled with phosphorus, which is scarce and expensive. In consequence the supply is at present limited.

The No. 27 (white phosphorus) grenade is being introduced to replace the P bomb. It can be used either as a hand grenade or as a rifle grenade with a range up to about 200 yards. At

present 20 per cent of rods and cartridges are supplied, but on the introduction of the new cup discharger all No. 27 grenades will be capable of use as rifle grenades. P bombs and No. 27 grenades are primarily designed as infantry weapons for offensive operations, and are suitable for burning dugouts, blinding machine guns, or screening small local attacks. Owing to their scarcity it is very uneconomical to use them in forming large smoke screens. It should be noted that on exploding these bombs scatter burning phosphorus over a circle of about 15 to 20 yards radius.

Single smoke cases, type S, are more easily obtained than P bombs or No. 27 grenades, and are less costly to manufacture. As smoke producers they are slightly less efficient than P bombs, and have practically no incendiary effect. They are portable and are designed for use by infantry in active operations. They are suitable for producing smoke which is intended to simulate gas or to be mixed with gas. They are useful for blinding machine guns or for screening local attacks, but are not so suitable for this purpose as P bombs or No. 27 grenades. They may be used for concealing concentrations of guns or troops, battery positions, or areas.

The following table gives a rough idea of the comparative weight of phosphorus and approximate efficiency of the several smoke-producing articles:

Article.	Weight.	Efficiency.
No. 27 grenades	14 ounces white phosphorus.	3
P bombs	16 ounces red phosphorus.	3
18-pounder	10½ ounces white phosphorus	1
4.5-inch howitzer	4 pounds white phosphorus.	10
4-inch Stokes (light)	4½ pounds red phosphorus.	10
4-inch Stokes (heavy)	7½ pounds white phosphorus.	15

Eighteen-pounder and 4.5-inch howitzer smoke shells and 4-inch Stokes mortar smoke bombs are filled with phosphorus and have a considerable incendiary effect.

They are suitable for—

(*a*) Blinding enemy observation points, both in attack and defense.

(*b*) Forming a smoke screen to conceal an advance from observation from a flank.

(*c*) Blinding salients in the enemy's line from which enfilade fire is expected.

(*d*) Blinding commanding ground and suspected machine-gun positions.

(*e*) Improving the screening effect in a barrage of shrapnel or H.E. (applies to gun and howitzer smoke shell only).

The supply of both shells and bombs is, however, strictly limited. Which should be employed on any given occasion will depend primarily on the resources available and the range to the points at which it is desired to form a screen.

As a general guide it may be taken that the following number of shells are required to form an adequate smoke screen under normal conditions:

18-pounder smoke shell: Two rounds per 10 yards per minute.

4.5-inch howitzer smoke shell: Two rounds per 15 yards per minute. Successful results have been obtained by firing groups of eight shells at 200 yards' interval per two minutes with a flank wind of moderate velocity.

The incendiary effect of these shells is quite considerable. Showers of burning particles are scattered around within an area of about 10 yards' radius.

The stronger the wind the farther must be the source of the screen from the object. Experiments have shown, however, that a screen can be formed even in a strong wind. The best wind for the use of gun and howitzer smoke shell appears to be one having a velocity of about 14 miles per hour (20 foot-seconds) and blowing across the object to be concealed.

One hundred yards per 10 foot-seconds of wind may be taken as a general guide as to the distance from the object at which artillery smoke shell should be placed. The smoke will rise to a height of at least 200 feet.

For the 4-inch Stokes a gentle wind of from 2 to 4 miles per hour is the best.

In forming a screen with the 4-inch heavy bombs 10 per cent might be burst in the air and the remainder on the ground.

The 4-inch Stokes smoke bomb has a maximum range of 450 yards with the light bomb and 900 yards with the heavy bomb. The mortar and ammunition are heavy and not very portable. Cases have occurred, however, in which, by making special arrangements for carrying parties, 4-inch Stokes mortars have been taken forward with the advancing troops and have succeeded in coming into action and forming a flank screen at a suitable moment during the advance.

Phosphorous smoke is the most persistent form of smoke available. In a wind of 3 to 6 miles an hour the depth of a cloud established by 4-inch Stokes mortars approaches 2,000 yards; with winds of higher velocity gaps are apt to develop in the cloud at distances over 1,000 yards from the burst of the bombs.

Considerations Affecting the Quantities of Smoke-producing Substances Required to Form a Screen.

The amount of smoke-producing substances required to form the screen depends on many considerations, the most important of which are as follows

(*a*) The extent of the screen: As a rough guide it may be assumed that the width of the screen should be from two to three times the width of the object to be concealed (as seen by observers from the points which are to be protected from the enemy's observation).

(*b*) The duration of the screen.

(*c*) The direction from which the enemy can observe the object or area to be concealed: The greater the number of points from which an object can be observed by the enemy the greater will be the amount of smoke-producing substances necessary to conceal it. As a general rule more smoke is required to conceal an advance from observation from a flank than from observation from directly in front only.

(*d*) The distance of the object from the enemy's observation posts: The greater this distance the more effective the smoke cloud.

(*e*) The direction of the wind: The difficulty of concealment increases if the direction of the wind is variable. In such a wind the smoke source should be mobile, as it may become necessary to change its location from time to time. Failing this, it may become necessary to stop the generation of smoke altogether.

(*f*) The velocity of the wind: The density of the smoke cloud diminishes considerably in proportion as the velocity of the wind increases. In a wind of over 20 miles per hour it is practically impossible to form an opaque screen.

It should be noted that in hot weather the smoke tends to rise from the ground, and there is a greater tendency for gaps to form.

It should be remembered that the effect of phosphorous bombs of all kinds is cumulative, as the globules of phosphorus continue to burn on the ground for from 15 to 30 minutes.

As the cloud in the case of phosphorous projectiles is at its thickest soon after the burst, it will be maintained more evenly by adding small quantities at frequent intervals of time rather than by adding large quantities at greater intervals.

To obtain the best results with the greatest economy in smoke-producing substances, it is necessary that the formation of the smoke screen should be very carefully organized. All personnel required for providing smoke screens should be trained beforehand in the use of the actual material which is to be employed. A simple rehearsal beforehand is most valuable. The program which is to be followed should state in detail the rate of expenditure of the smoke-producing substances and should be given in writing to the personnel of each smoke source.

No definite rules can be laid down as to the exact quantities of smoke-producing substances required to form a screen, as the conditions vary to a very large extent.

The following examples are given for guidance:

Examples of Smoke Screens.

(1) Object to be concealed: Concentration area on a front of 2,000 yards.

Direction of the wind: Parallel to the enemy's trenches.

Velocity of the wind: Six to eight miles an hour.

Material available: Single smoke cases, type S.

A smoke screen should be formed 4,500 yards long and 400 yards in front of the forward edge of the concentration area.

Groups of two men each should be placed 150 yards apart on the line of the intended screen. Each group should light six smoke cases every 2 minutes. Thus, if the screen is to be maintained for a period of 2 hours, 10,800 smoke cases will be required.

Personnel required, 60 men.

The men should take advantage of any cover available, and each group, if possible, should be provided with a watch.

(2) Object to be concealed: Concentration area on a front of 2,000 yards.

Direction of the wind: Toward the enemy.

Velocity of the wind: Six to eight miles per hour.

Material available: Single smoke cases, type S.

A smoke screen should be formed 4,500 yards long and 400 yards in front of the forward edge of the concentration area.

Men should be posted singly and 25 yards apart along the line of the intended smoke screen. Each man should light one smoke case every 2 minutes. Thus, if the screen is to be maintained for a period of 2 hours, 10,800 smoke cases will be required.

Personnel required, 180 men.

(3) Object to be concealed: Concentration area on a front of 2,000 yards, from a balloon at an altitude of 3,000 feet and 6,000 yards distant.

If the smoke screen is formed 400 yards in front of the forward edge of the concentration area, it would be necessary to have a smoke screen 200 feet high in order to conceal the forward edge of the concentration area from the balloon, and much more than that to conceal the rear edge. A certain amount of screening effect might be produced by bursting 4-inch Stokes bombs in the air, but this method can not be relied upon, and is uneconomical.

As already stated, therefore, it will seldom be possible to use smoke successfully to screen areas or objects from hostile kite balloons, unless there happens to be a considerable rise in the ground between the balloon and the object to be concealed and on the top of which the smoke screen can be formed.

P Red Phosphorus Bombs.

Front to be screened, 150 yards.

Ten men extended to 15 paces. Each has ready in a sandbag:

1 P bomb with detonator and Brock lighter.

8 P bombs without detonators.

1 strip sandbag soaked in paraffin.

1 piece corrugated iron 2 feet by 1 foot.

1 knife with tin opener.

1 box matches.

On whistle signal the detonated P bombs are thrown 15 yards down wind and burst. Each man then opens a P bomb with tin opener and spreads red phosphorus over square foot of corrugated iron, leaving one end free for carrying if wind changes. The phosphorus is lighted as soon as possible by means of the strip of sandbag soaked in paraffin. The contents of a fresh P

bomb are added to each burning pile every 15 minutes. Fresh phosphorus must not be added by every man at the same time or the cloud will diminish.

Duration, 2 hours, 90 P bombs.

NOTE.—P bombs must not be opened previous to operations, as the phosphorus is liable to catch fire spontaneously.

4.5-INCH SMOKE BARRAGE.

A method adopted on one occasion was as follows:

The four guns of the battery were concentrated on a point 400 yards to windward of the place where the commencement of the barrage was required. The wind at the time was 40 foot-seconds; the relation of the distance, 400 yards, to the wind, 40 foot-seconds, may be worth noting.

The guns were fired at battery fire (10 seconds) and the result was effective.

NOTES ON SCREENS (PROVISIONAL).

(Issued by the General Staff.)

Employment.

Screens are extensively employed for the purpose of concealing from direct observation—

(*a*) Roads, tracks, trenches, or areas.

(*b*) Ground which is waterlogged, where it is impossible to dig communication trenches, and over which it is necessary to move troops.

(*c*) Battery positions or gun flashes.

(*d*) Work in progress.

(*e*) Dumps.

Also for the purpose of—

1. Thickening hedges which are not sufficiently opaque of themselves.

2. Encouraging the enemy to waste ammunition.

Their main function is concealment, so that the enemy can only fire on the chance of there being a target behind them, instead of at an observed and definite object.

Types.

To be effective, screens should fulfill the following conditions:

They must be opaque enough to achieve the purpose for which they are erected and at the same time not susceptible to extensive damage by weather or shell fire. If damaged, they must be easy to repair.

The forms of screening generally found of most value are:

1. Wire netting garnished with grass, brushwood, or canvas strips.

2. Brushwood interwoven in horizontal wires stretched between rigid uprights.

Shell fire has practically no effect on such screens unless a direct hit is obtained, and even then, if properly constructed, the effect is very local. They also stand the weather well. Grass screens when dry are, however, somewhat inflammable.

Other Forms.

(A) In certain cases solid canvas screens are necessary—e. g., to hide flashes or movement at close range (up to 2,000 yards).

They are highly susceptible to damage by weather or shell fire, must be extra firmly supported, and, if possible, backed with wire netting.

(B) Coir screening (which is a generic term for coconut or jute matting) in single thicknesses is transparent. Used double it forms an excellent and quickly constructed screen. It is useful as a temporary expedient, but does not weather well. It should always be reinforced with longitudinal wires.

Opacity.

It must be recognized that perfect opacity under all conditions of light and background can only be obtained by the use of perfectly opaque material, such as corrugated iron. Canvas itself is not always opaque—e. g., when the sun is low behind it.

One must therefore be satisfied with a compromise—a screen that is comparatively opaque under normal conditions; that is to say, one which hides movement from anything but close and continuous scrutiny.

The screening effect is much influenced by the background and the angle of view. A comparatively transparent screen may be successful if the background is of a color generally similar to the objects to be screened, is broken by trees and hedges, or is viewed from an angle other than at right angles to its surface.

Unless assisted by natural accidents of environment it is necessary that three-quarters of the surface of the screen should be made of opaque material if it is to hide movement at medium range (2,000 to 4,000 yards).

Visibility.

There are two distinct categories of screens:

1. Those which are obvious to the enemy as screens.

2. Camouflaged screens, designed to conceal and yet escape detection themselves.

These latter are either made of—

(*a*) Solid painted canvas or wire netting garnished with strips of canvas, grass, etc., colored in patches to present a general landscape effect or to represent hedges,

(*b*) Solid canvas carefully painted to reproduce a definite locality—brick wall, ruins, and such like.

Camouflaged screens can rarely serve their purpose for any length of time, and are only in exceptional cases (where they are only required for a few weeks) worth the time and trouble expended on their manufacture.

Their defects are:

1. That the effect obtained by painting will only last a short time when exposed to weather, and will not vary with the natural seasonal changes in surroundings.

2. That they require greater care in construction and more maintenance, are highly susceptible to damage by weather and shell fire, and are inflammable.

3. That it is very doubtful whether they deceive the enemy; should they not do so they are only performing the function of an ordinary screen, i. e., that of concealment, but have taken longer to construct.

It is to be remembered that they are exposed to steady direct view as opposed to the comparatively fleeting examination from an aeroplane to which camouflage gun covers are exposed.

The following are examples of the successful use of camouflaged screens:

1. Work on exposed battery positions about 1,800 yards from the enemy's front line was made possible by the erection of screens composed of raffia on wire netting. These screens were mounted on wooden trestles, of a maximum height of 10 feet. These enabled the raffia netting to be put up at a slope and so to simulate a bank or false crest. The extremities of the screen were sloped gradually to the ground by using progressively lower trestles. Both front and back slopes were furnished with raffia netting, in order to give sufficient thickness to conceal flashes. The top of the screen was made irregular to avoid a hard outline, and the slopes were gentle.

2. In another instance imitation brick walls painted on canvas backed with wire netting were erected for a similar purpose.

3. Imitation hedges were made of a combination of raffia, canvas strips, and brushwood on wire netting to conceal a battery position which otherwise would have been in direct view. In this case an existing hedge that was in rear of the position, from behind which the guns were unable to fire, was removed, and the imitation substituted in front of the guns.

It is a general experience that newly erected screens are shelled by the enemy for a short period after erection, but that he soon gives this up if damage is repaired immediately.

A good example of this can be given in a case where over 7,000 yards of screening, consisting of hay bands interwoven in wire netting were erected five months ago. No attempt was made to render the screen inconspicuous. It was shelled to some extent, but any damage caused was immediately repaired. The screen is still fulfilling its purpose, i. e., that of concealing what goes on behind it.

There is no doubt that if screening is carried out on a comprehensive scale, and with a continuous policy, localities which would normally be under observation and subject to deliberate shelling become practically immune, and this does not depend upon the invisibility of the screening erected but on the distribution.

Siting.

Roads running at right angles to the front line are best concealed by hanging vertical screens between trees, houses, or poles across the road.

For roads running parallel with the front line it is advisable, when possible, to site the screens at least 50 yards from the road in order that shell fire directed at the screens should not cause damage on the road and vice versa. Additional advantage may be gained by varying the distance, and using lengths of screen en échelon.

Such screens may have to be made specially high, but at the same time the lower edge can be correspondingly some distance off the ground.

Short lengths of about 30 yards placed en échelon, and overlapping each other, are preferable to long lengths. This method permits of passage way, and limits damage by shell fire, and the line of route screened not being defined, becomes difficult to range on.

Screens have been used successfully to hide gun flashes from the front and from a flank at night.

In one case where the flashes were visible from a flank, a long solid canvas screen (painted a dark color) was placed 50 to 100 yards on the right front of the battery. This was found difficult to maintain, and six small screens were substituted, one about 4 yards to the right of the muzzle of each

gun, and running out about 8 yards to the front. They were about 8 feet high, of which only the top 6 feet was canvas. They were dismantled during the day and reerected each night in socketed holes.

Manufacture, Erection, and Maintenance.

Whenever possible, screens should be attached to existing objects such as trees, hedges, houses, etc. If poles have to be used instead, they should be sunk well into the ground and well guyed.

The screen should be both suspended from longitudinal wires and fastened with staples to the poles.

The following methods of bracing have been found satisfactory:

1. The uprights joined by longitudinal wires 3 feet apart and guyed to stout pickets set midway between each pair of uprights. Each upright is therefore secured to four pickets, two of which are shared by the upright on either side.

2. Cross diagonal bracing between each pair of uprights, which are guyed in the normal way.

Guys should consist of at least four strands of No. 14 gauge wire or their equivalent.

Uprights should be of at least 3-inch timber.

It is convenient when manufacturing screens in back areas to make them up in bays of 30 feet, with intermediate supports 10 feet apart, 30 feet being a fifth part of an ordinary roll of wire netting and a convenient length to handle.

In order to localize the effect of shell fire, it has been found advisable to hang each longitudinal width of wire netting independently on a longitudinal wire between the uprights.

It is important that the manufacture and assembly of screens should be well organized, so that the actual erection can be carried out rapidly.

The adoption of a standard type of screen, which suits the locality and will serve anywhere, will result in economy of time and labor.

Strips of canvas interlaced in wire netting will make such a screen. The strips should be 2½ inches wide, and threaded through every three or four meshes vertically, leaving no interval horizontally except for the twisted wire between adjoining meshes. The opacity is considerably increased by the

use of alternate vertical bands of plain and dark-colored canvas, each band being about a foot wide. It is important that there should be a strong contrast between the plain and colored canvas. This screen is effective from ranges of a mile upward.

Still better results can be obtained if the color is arranged on the vertical bands so as to produce a checkered effect. This can easily be done in the manufacture, for the screens are made up of wire netting (which is 3 feet wide), which are subsequently joined to form screens 6 feet or 9 feet high. It is simple to arrange either in the manufacture or in the assembling, that the colored band on one 3-foot width is mated to a plain band on its neighbor above or below.

It is recommended that maintenance parties should be detailed to effect immediate repairs, and that a reserve dump of material be formed near any extensive range of screens that are likely to be damaged.

INSTRUCTIONS FOR THE DEMOLITION OF HOSTILE GUNS WITH 3-INCH STOKES TRENCH MORTAR BOMBS AND SPECIAL SLOW FUSE.

(Issued by the General Staff.)

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1. A slow fuse should be made up of a length of Bickford fuse with a fuse lighter fixed to one end and a No. 8 detonator crimped to the other end. The fuze should be cut to burn for 1½ minutes.

It has been found convenient to pack the fuses in tins containing 10 fuzes and 4 spare fuze lighters. The contents should be labeled on each tin.

Care must be taken when crimping the detonator onto the Bickford fuze to leave a space of one-fourth inch between the end of the Bickford fuse and the fulminate.

2. The bombs are the ordinary 3-inch Stokes bombs without their fuses or components.

3. To demolish a hostile gun:

(*a*) Open the breech, place the bomb in the breech of the gun, with a cartridge container forward as far as it will go.

(*b*) Insert the detonator end of the slow fuse into the gaine tube of the bomb and press it gently home. Secure the fuse so that the weight of the fuse lighter does not pull the detonator out of the bomb.

(*c*) When the gun has thus been prepared, withdraw the safety pin from the fuse lighter and press the cap down, at the same time turning it around. As soon as the fuse is lit, take cover.

NOTE.—(1) The normal rate of burning of Bickford fuse is 1 yard in 90 seconds, but this time may vary by as much as 15 seconds in either direction.

(2) In taking cover the party should spread out and warn off any approaching troops. The fragments may carry 300 yards.

(3) If the breech can not be opened—

(*a*) In the case of a field gun, place the bomb between the gun and the seat (so that it touches the gun) on the muzzle side of the shield.

(*b*) In the case of any larger gun, place the bomb just inside the muzzle, taking care that the bomb does not slide down the bore.

DEMOLITION PARTY.

A demolition party should consist normally of one noncommissioned officer and two men. The noncommissioned officer carries two Stokes bombs and one tin of slow fuzes. Each man carries four Stokes bombs in two sandbags.

The men should be practiced in their duties before being sent into action.

EMPLOYMENT OF 3-INCH STOKES MORTARS IN RECENT FIGHTING.

(Issued by the General Staff, June, 1917.)

The following examples of the employment of 3-inch Stokes mortars during recent fighting are published for information:

1. A 4 minutes' barrage was put up preparatory to a brigade attack, with the object of smothering five hostile machine guns. The range was 550 yards, and two ballistite rings and green cartridges were used. The machine guns did not fire and the attack was successful.

2. Twenty rounds were fired by a mortar on a party of Germans who had become isolated, whereupon the party left the trench in which they had been holding out and tried to escape by retiring. Range was rapidly lengthened and some rounds fired over their heads, with the result that they came back and surrendered; prisoners taken, 2 officers and 70 other ranks.

3. During two counter attacks about 200 rounds were fired at the advancing enemy; when all their ammunition had been fired the detachment lent effective support to our resistance by using their rifles.

4. A noncommissioned officer in charge of a mortar observed some enemy working in front of our trench; by firing over them and gradually shortening range, he drove two of them toward our trench and compelled them to surrender.

5. A mortar was trained onto a party of Germans who were observed trying to get a light Minnenwerfer into position. These scattered at the second round, leaving the gun in the open. Eight carefully registered rounds were fired at the gun and then two bursts of fire. Three direct hits were obtained and the gun was blown up.

GERMAN DOCUMENT—PRINCIPLES OF COMMAND IN THE DEFENSIVE BATTLE IN POSITION WARFARE.

I. Infantry.

Energetic steps must be taken to insist on the infantry in the line continuing their work on their position, even during the fighting. Personal inspection by all infantry commanders, and by the higher commanders, is necessary to insure this.

By night, and especially in misty weather, for example, it will often be necessary to strengthen the garrison of the front line or to bring reserves up closer to the front line. In foggy weather a special form of "readiness for action" must be provided for.

Gaps between defensive works are a source of danger. They must be commanded by fire from the rear and the flanks, and be kept under observation by the infantry and artillery. By night and in misty weather they should be guarded by outposts.

The main points to be considered in the stationing of all reserves are to keep them concealed, and to distribute them skillfully over the area, so as to avoid unnecessary losses. Isolated farms, copses, hollows, and roads which lie in valleys, should be avoided, as experience teaches that they are always heavily shelled.

When fighting takes place in open country or in positions which afford but little cover, efforts must be made to hold the front line with weak detachments, while the rest of the force is distributed in great depth, as would be the case in a strongly constructed position.

When a hostile attack begins with prolonged intense artillery preparation by the heavy and heaviest calibers of artillery and trench mortars, the foremost trenches are speedily converted into shell-hole positions, in which infantry "nests," composed of isolated groups, are formed round the sentry posts and dugouts, wherever these still exist.

It is essential that the men should be trained to connect up such points with each other and with the trenches in rear during pauses in the fighting, by night or during misty weather.

The influence of the company and subordinate commanders in fighting in such shell-hole positions often extends only to the men who are actually with them. In such circumstances stout-hearted men with iron nerves form the real backbone of the defense. All commanders in the front line, senior or junior, must, however, continually endeavor to keep their men capable of offering resistance and ready to make a counter attack by setting a personal example of calm and courageous behavior.

In fighting of this character it is no longer advisable to strengthen the garrison of the fighting line and to reinforce it continually. The garrison sustains heavier losses, which are continually recurring and which, because they are unnecessary, are bad for the morale of the troops. The maintenance of the foremost positions, moreover, can not be insured simply by a rigid defense, combined with the reinforcement of the garrison of the front line.

To secure this object, tactics of a different character must be employed.

The garrisons of the foremost trenches must be weak, but they should not be tied rigidly to one point when they can no longer find cover and may, within certain limits, change their position in order to escape from a very intense bombardment. Experience shows that no matter how carefully the enemy directs his fire there are points within every area allotted to a unit in which this fire is less effective. It is, therefore, a question of observing the fall of the enemy's fire and of avoiding the areas in which it is most intense by advancing, moving to the flanks, or falling back on the nearest supports. The best method is to advance, as this is the quickest way of escaping from the enemy's fire. In movements to the flanks or toward the rear to the nearest supports, there is some danger of the continuity of the fire line being broken, and of the enemy establishing small nests in it unobserved. Efforts must, therefore, be constantly made by the detachments in the shell holes not to lose sight of one another, and the front line must be continually under observation from the rear.

If the enemy leaves his trenches to attack our lines, every infantryman must realize that the most certain means of repelling the attack are his own rifle fire, hand grenades, and the bayonet, and that even a few machine guns will break up a hostile attack. The employment of artillery is a valuable assistance in repelling an assault, but it is not of itself sufficient to repulse a strong attack.

Every rifle and machine gun which can be brought to bear on the enemy's attack, either from the fire line or from defensive positions in the rear, must be directed against it, in addition to the annihilating and barrage fire of the artillery, trench mortars, and bomb throwers (granatenwerfer).

If, in spite of this, the enemy succeeds in entering our trenches, the task of the artillery is to cut him off from the attacking waves and reserves which are following him up, while enfilade and frontal fire (rifle, automatic rifle, and machine gun) is opened on the enemy who has entered our trenches, to prevent his further advance. Trench mortars and bomb throwers, in particular, should be employed to keep the enemy under fire while he is consolidating the position, although the artillery may also take part in this, if observation can be insured.

The difficult situation in which the enemy now finds himself must be utilized without waiting for further orders. The detachments of the trench garrison who are retiring to the flanks and to the rear, and the supports lying ready behind the foremost trenches, whose task must have been so drilled into them as to become second nature, must counter attack immediately and recapture the front line. They must in some cases advance under hostile artillery fire. The enemy must be annihilated to the last man by the use of the hand grenade and the bayonet in hand-to-hand fighting.

An essential preliminary to the successful employment of these tactics is to make certain that the infantry can observe the foreground and the area between the lines.

Men detailed to guard particular points (emergency garrisons) do not take part in counter attacks.

If the counter attack is successful, the front line must immediately be placed once more in a state of defense, but the garrison must then be reduced to its previous strength. These tactics cause the fighting to take place not in, but for, the front line.

It is essential that the men should be thoroughly trained in these tactics, and that the subordinate commanders and men are given clear, precise, and detailed instructions as to what they have to do on the spot. The utmost demands must be made on every man who takes part in the attack.

If the garrison of the foremost battle zone is unable to eject the enemy or hold him, a combined attack should be delivered with the general reserve, while the enemy is still engaged in organizing the defense of a strange system of trenches and in fighting the local reserves for "holding on" points, etc. Every

man who is fighting in the forward battle zone must realize clearly that by holding out, even if he is completely surrounded, he makes it easier for the counter attack which is certain to be delivered, and is contributing to his own relief. He must, therefore, go on fighting so long as he can use his weapons.

The attack itself should be delivered in waves in extended order, assault detachments being employed at some points. The attack must be supported by the fire of machine guns pushed forward in echelon, by bomb throwers and trench mortars, by infantry guns as well as by the artillery farther in rear. The success of the attack depends not on the strength of the forces engaged in it, but on the resolution with which it is carried out, the cooperation of all arms, and rapidity of execution.

A decisive factor in the success of an attack is the selection of the right moment for the employment of the reserves posted farther in rear. It must be remembered that many requests for support from the front line are, as experience shows, either not justified by the situation or made too soon. If the reserves are alarmed and brought up prematurely, their energy is frittered away and the subordinate commanders are tempted to hold the front line with too large a force.

If an immediate attack does not succeed in ejecting or annihilating the enemy who has entered the position, this can only be retaken by a methodical attack.

Reliefs.—The frequent relief of the infantry is undesirable from the point of view both of command and of the troops themselves, as the change prevents the troops becoming familiar with the position and diminishes their keenness in working to improve it.

Experience shows that confusion often arises while the relief is being carried out, and ground is lost in consequence.

Precautions must be taken in advance, to insure that there are other communications, which have been reconnoitered and clearly marked out, to replace routes which have been discovered by the enemy and are blocked by his fire.

II. Artillery.

Searching and sweeping fire (unless it can be kept within narrow limits by working with the assistance of suitable registration points situated close to the target, combined with an exact study of the map) and bursts of fire with H. E. shell against groups of the enemy's guns are, as a rule, useless. On

the other hand, searching and sweeping fire with gas shell may be very useful to put artillery out of action for the time being. Gas shell are not suitable for counter battery work which aims at the destruction of the hostile battery.

When the trenches are separated by medium distances (about 165 to 220 yards), barrage fire should fall on and close in front of the enemy's foremost trenches, as otherwise the safety of our own trench garrison, which is not to be jeopardized on any account, can not be insured. If the enemy's jumping-off trenches are so close to our own lines that barrage fire would endanger our own infantry, it must be left to the trench mortars, bomb throwers, and infantry to keep them under fire. The artillery barrage fire should then be directed against the enemy's rearward positions, in order to cut off his foremost waves of assault from their supports and to catch the latter while they are concentrating. If the enemy's foremost trenches are farther from our lines (i. e., more than 330 yards), the barrage fire must follow the progress of the enemy's attack.

Artillery action against the enemy's tanks is of particular importance in the repulse of an attack, in view of the novelty of the weapon and the small amount of experience so far gained.

Destructive and barrage fire, which is directed against hollows, roads, and the enemy's positions, will probably often stop tanks by its very intensity, so that only a few will reach or penetrate our lines.

Artillery action against these will be carried out by infantry guns and close-range guns which fire with direct laying at short ranges. They are equipped with a special projectile for this purpose. It is important that these guns should not open fire too soon, so that they remain concealed and are still in action when they are needed.

In addition to these guns, heavy howitzer batteries should be detailed to engage tanks. They will have particular zones allotted to them as targets—i. e., as a rule, strips of ground close in front of our lines which they can keep under observation, and on which they must register when conditions are quiet. If a tank enters the zone allotted to a battery, all the guns should be turned on the tank and salvos should be fired until it is out of action.

Nothing but a thoroughly organized bombardment such as this will be successful against tanks. General orders that all batteries which observe tanks approaching are to open fire on them only lead to confusion and failure.

In exceptional cases heavy, flat-trajectory guns, fire with direct laying and direct observation, may prove effective, for example, if tanks have broken through our lines.

Artillery commands.—The artillery allotted to armies to reinforce them for the defensive battle should, in principle, be distributed amongst the divisions in proportion to the importance of the various divisional sectors.

Artillery should not be massed; distribution in depth causes the enemy to scatter his fire.

III. Air Forces (including Antiaircraft Defense).

(*a*) It is necessary to increase the air forces very considerably—reconnaissance and artillery aeroplanes, single-seater battle planes, captive balloons, and antiaircraft weapons—before the actual defensive battle, as the first objective of the enemy's attack will be to secure complete mastery of the air. This must be stopped as soon as possible.

As soon as the reinforcement of the threatened front is ordered, owing to the situation having become clear and the decision to thwart the enemy's plan having been taken, the air forces and antiaircraft weapons must be further considerably increased. Less important fronts must without hesitation be ruthlessly denuded of aeroplanes, balloons, and antiaircraft weapons.

IV. Pioneers.

(*a*) Pioneers are on no account to be employed on tasks which the infantry is capable of performing.

(*b*) The pioneer commander of the division is also in command of the pioneer battalion of the division. The pioneer and minenwerfer companies and the searchlight section of the division should be under his orders, and, as a rule, the labor companies as well. The divisional commander will arrange for the command of the pioneer and minenwerfer companies and searchlight units, which are temporarily attached to the division.

(*c*) In a defensive battle, minenwerfer have a special task to perform in engaging tanks. Special zones in front of our lines, which they must be able to keep under observation with certainty, should be allotted to the heavy and medium minenwerfer, in the same way as to the heavy artillery. If tanks enter these zones the minenwerfer concerned will divert their fire from all other targets and direct it on the tanks.

CONSOLIDATION OF TRENCHES, LOCALITIES, AND CRATERS AFTER ASSAULT AND CAPTURE, WITH A NOTE ON RAPID WIRING.

(General Staff, War Office.)

1. Consolidation of a Captured System of Trenches.

The capture of a system of hostile trenches is an easy matter compared with the difficulty of retaining it. A thorough knowledge of the principles, a careful study and correct use of the natural features of the ground, and a detailed preparation and organization of the work are necessary; but success will only result if there is also an absolute determination on the part of all ranks to get the work done promptly at all costs.

The principles of the consolidation of captured trenches are, briefly, as follows:

(*a*) To establish a series of strong points or centers of resistance, wired all round and mutually supporting each other according to the ground. These points should be provided with machine or Lewis guns at once.

(*b*) To provide good communication to the rear from these points.

(*c*) To fill in all hostile trenches within bombing distance of the points occupied.

(*d*) To establish, if possible, simultaneously with the consolidation of strong points in the front line, a number of supporting points in rear. These points should, if the ground is favorable, be placed to cover the intervals between the works in the front line.

(*e*) The strong points can later be connected to form a continuous front line.

The above principles must be applied with due regard to the natural tactical features of the ground. The satisfactory siting and consolidation of a position will largely depend on the power possessed by the officers on the spot to recognize during the various stages of a battle the minor features of real tactical im-

portance. This ability is only acquired by previous training, and is a quality which every officer must study to possess. The size and trace of the "strong points," as well as the intervals between them, will vary according to the lie of the ground and the plan of the hostile trenches captured. During the process of consolidation concealment from artillery observation is of importance.

The first essential is speed in rendering the captured position strong enough to resist the first counterattacks. It is therefore necessary that a definite plan should be decided on beforehand as to which points first require attention. This can be done, in the majority of cases, with great accuracy from maps and aeroplane photographs and from a study of the ground from any point in our lines which commands a view of it. In the case of craters the forecast of the tunneling officers must be obtained.

Although it is usually advisable that assaulting troops should be relieved as soon as possible, this must not be taken to imply that the duty of securing ground gained is the task only of the relieving troops. It is an unsound principle for troops to expect to be relieved immediately after an attack, as it wastes valuable time at a critical period when speed in work is essential. It must be understood that troops which take a position must commence the work of consolidation at once.

The distribution of R. E. detachments requires to be carefully considered beforehand. In all cases of an assault or advance, where it is intended to secure the ground gained, the troops destined for the purpose should include a detachment of R. E., the commander of which should be detailed previously and attached to the staff of the unit or formation concerned.

Garrisons must hold on to their ground; they have nothing to fear from being outflanked.

2. Consolidation of Localities.

During an advance, when it becomes necessary to consolidate some locality of tactical importance, such as a village or wood, the same general principles hold good as in the consolidation of a system of trenches. Some notes on the particular points that require attention in the case of villages and woods are appended.

VILLAGES.

Enlargements from even small scale maps give very accurate plans of most villages and make it possible to plan the defense

in sufficient detail beforehand. It is essential that subordinate commanders should be provided with such plans in order that the general idea of the defense may be quickly and properly understood.

The principles of the defense of a village are laid down in Infantry Training, section 146. The order of urgency of work is as follows:

(*a*) Barricade and picket all exits. Establish center of resistance near exits to cover approaches or any streams or tracks which might serve to guide a counter attack. Commence work on keep, preferably at village crossroads. Barricade roads.

(*b*) Reconnoiter for cellars.

(*c*) Establish communications, giving cover from view, radiating from keep to outer centers of resistance, and from keep to the rear.

(*d*) Construct bombproofs in cellars at centers of resistance and keep—false roofs to cellars, etc.

(*e*) Complete keep.

(*f*) Improve communications at (*c*) above, to give cover from fire.

(*g*) Make lateral lines of communication between centers of resistance.

Centers of resistance should be established, if it is possible to do so, to the flank of conspicuous buildings likely to afford good targets for hostile artillery fire. In the case of keeps in villages, this is often impossible owing to the presence of church spires. It is, however, preferable to have a keep, even with this disadvantage, that is central, accessible, and strong against infantry assault. It should be remembered in this connection that by the time hostile infantry can assault a village keep hostile artillery fire will necessarily have ceased.

WOODS.

As in the case of villages, plans should be prepared of the locality.

There has been much discussion in the past as to what part of a wood should be occupied. Experience has proved that, owing to the great advantages afforded by cover from view, the position to take up in a wood is just so far within the outer edge as will permit of good view into the open. In this connection it should

be remembered that in course of time shell and rifle fire thins out the edges of woods considerably. It is therefore advantageous in the first instance to take up positions slightly in rear of those which may appear at the moment to be most advantageous.

If, as is often the case, the wood is surrounded by a hedge, there is a natural tendency to make trenches against this hedge. This is to be avoided. A hedge forms a very good obstacle against assault, with the addition of a little wire. If it screens the view, it can be quickly thinned.

The order or urgency of work is as follows:

(*a*) Establish centers of resistance for all round defense at the corners and salients of the wood. These are the points which are most liable to counter attack. Establish central reserve, reconnoiter, blaze, and clear communications. The defense of a wood should be very active, and counter attacks must be launched against any hostile troops that may reach the edge of the wood in order to prevent a lodgment that places the enemy on equal terms.

(*b*) Establish intermediate centers of resistance and lateral communications.

(*c*) Establish central keep at junction of rides or on near edge of clearing.

In the case of large woods and forests, where the general line of defense runs through a wood, a line of strong centers of resistance should be established across the wood, if possible behind a road or other clearing. The near edge of the clearing should be entangled, and the intervals between the "centers" should be swept by fire. As time permits "rays" should be cleared, radiating from the centers of resistance and crossing similar "rays" from adjoining centers, so as to add to the depth of the field of fire.

These rays should be wired and obstacles arranged, so as to break up an attack and force the attackers into the openings.

A line of intermediate centers, communications, etc., should also be established, as indicated in (*b*) above.

3. Occupation of Craters.

I. The occupation and consolidation of mine craters presents many difficulties, and all ranks should understand the principles to be acted upon in the event of the explosion of mines on their front.

II. Craters are usually formed as a result of one of the following mining operations:

(*a*) An attack by us on the enemy's trenches.

(*b*) An attack by the enemy on our trenches.

(*c*) Underground fighting.

III. The possession of a crater offers the following advantages:

(*a*) It can be turned into a strong point capable of holding a small garrison.

(*b*) It gives command of the ground in the vicinity.

(*c*) It forms a considerable obstacle.

IV. (*a*) When mines are exploded by us in connection with an attack on the enemy's trenches, our object should be to seize and hold the whole of the mine crater or craters or a line in front of them. The latter plan is usually the best, and the craters in rear can then be turned into strong points.

(*b*) When craters are formed as the result of an attack by the enemy on our trenches or in the course of underground fighting, our object will usually be to seize and hold the near "lip" of the crater.

Parties must be rushed out at once to seize the lip. It may be impossible to open up communication to these parties till after dark. They should therefore take sufficient grenades, water, etc., and must be prepared to hold on though isolated.

V. Before the explosion of a mine a forecast should be made of the state of affairs to be expected after the explosion, and all details of probable requirements should be worked out. These would include:

(*a*) The formation of dumps of engineer materials as close up as possible.

(*b*) The organization of working and carrying parties.

Work should start immediately after the explosion of the mine, and no time should be lost in turning into account the quiet interval which usually follows the explosion.

The personnel of R. E. field companies should be freely used for this work under instructions given through the general staff.

VI. The following are the main points to be attended to in the actual consolidation of the craters:

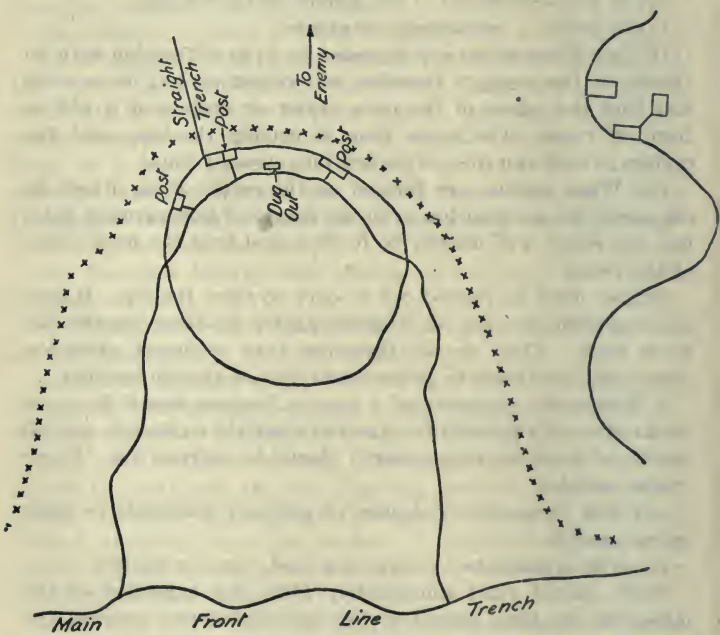
(*a*) All trenches should be strutted as they are constructed. Special frames for this purpose must be made beforehand.

(*b*) All works on a crater, whether inside or outside the "lip," should be provided with a parados.

(*c*) Dugouts should be made by tunneling into the sides and not at the bottom of a crater.

(*d*) At least two communication trenches should be constructed leading into each crater. Entrances to craters should be made at the sides and not through the rear "lip."

(*e*) All trenches leading up to a crater from the enemy's line should be straightened or filled in for a distance of at least 40 yards from the position of the defenders, so as to keep the



enemy bombers at a distance. This work can usually be carried out with the least difficulty immediately after the explosion.

(*f*) Collapsible knife rests, French wire, and other forms of portable wire entanglement should be brought up in large quantities and thrown over the "lip" of a crater.

VII. There are two main methods of holding craters:

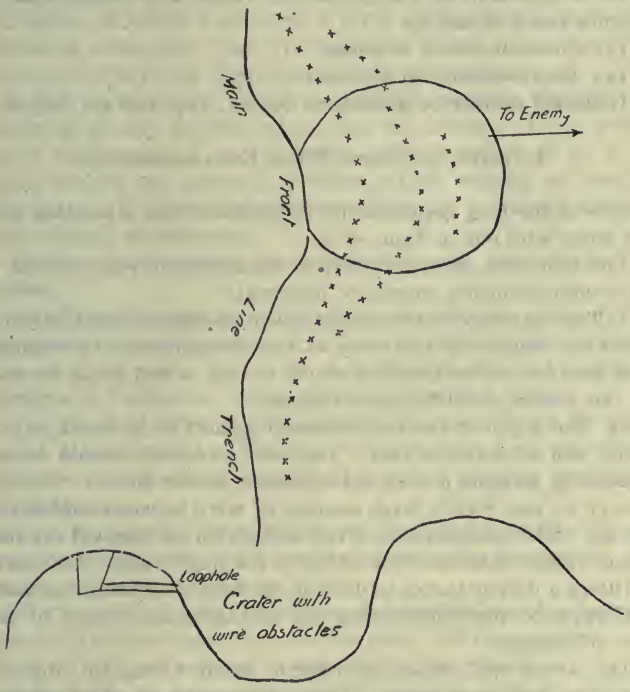
(*a*) Method A. (See sketch on p. 6 and Plate A.)

This method should usually be employed after the explosion by us of a mine in the enemy's trenches or in the area where it is known that the enemy is not engaged in mining.

The front "lip" of the crater is held by means of several posts. Two communication trenches lead into the crater, one on each side, and give lateral communication between the posts. One or two dugouts are constructed in the sides of the crater.

(*b*) Method B. (See sketch below and Pl. B.)

This method should usually be employed when the enemy has exploded a mine in or near our trenches, or when we have exploded a defensive mine close to our own trenches.



The rear "lip" of the crater is held. Wire is thrown inside the crater. One or two loopholes are cut through the rear "lip" so as to command the inside of the crater.

Plate C shows a scheme for converting the area behind the lips of a series of craters, which have been occupied, into a strong post.

The importance of rendering the means of access to the lip secure from bombing attack is not always recognized.

VIII. Work should be carried out in the following order:

(*a*) Construction of one or two posts in the lip of the crater.

(*b*) Wiring the front of posts and filling in or straightening trenches leading from it toward the enemy.

(*c*) Digging of communication trenches up to the crater.

And, if far lip has been occupied:

(*d*) Digging trench for lateral communication inside the crater.

(*e*) Completion of wiring front of crater and construction of further posts in far lip.

(*f*) Construction of dugouts.

(*g*) Improvements to the above.

It should usually be possible to do (*a*), (*b*), and (*c*) together.

4. Notes on Rapid Wire Entanglements.

One of the first requirements in consolidating a position is to get some wire out in front of it.

The following general principles regarding the construction of wire entanglements should be observed:

I. The rear edge of the entanglement should be about 20 yards from the trench; if the trace of the entanglement is irregular and does not follow the trace of the trench, it will make the task of the hostile artillery more difficult.

II. The depth of the entanglement should be as great as possible, and at least 30 feet. The wire available should be expended in forming a deep entanglement rather than a "heavy" one (i. e., one with a large amount of wire between each set of posts). The construction of two belts with an interval between them, rather than one belt of twice the depth, gives the hostile artillery a deeper target to destroy, without increasing the material required for constructing the entanglement, except by one row of pickets.

III. There will seldom be time in rapid wiring to "dig in" the wire for concealment. Every advantage should be taken, however, of natural folds in the ground, long grass, or brushwood, or other means of concealment.

IV. Wire entanglements should be 2 feet 6 inches to 3 feet high.

V. The posts in a row should be about 6 feet from each other and the rows about 6 feet apart. If wooden posts are used they must be strong; light posts are useless.

VI. The difficulties of crossing an entanglement are increased if it is not too regular; e. g., if the heights of the posts above ground and the distances between them are varied. For rapid wiring drill, however, a regular entanglement is easier to construct.

To insure that an obstacle can be erected with rapidity and in silence, every one of the working party must know what he has to do and work so that he does not get in the way of the others.

This necessitates some form of drill. There are a large number in use, of which a selection is given on pages 14 to 20.[1] The following notes and rules will be found useful in carrying out any form of drill for constructing wire entanglements:

I. The party should, as far as possible, work so that the obstacle is always between them and the enemy. Each wiring party should have a double sentry lying down about 30 or 40 yards toward the enemy to prevent patrols sniping or bombing the party. If circumstances necessitate it, a special covering party should be provided.

II. The party should work extended and not bunched together.

III. Large parties, in which each group of men has only one operation or duty to perform, will erect entanglements quicker than a small party, in which each man has several duties to perform in succession, unless latter is very well drilled.

IV. The best unit of entanglement is about 40 or 50 yards long. Its construction can then be controlled from one point. This distance is also a convenient interval to leave small gaps for patrols.

V. A line of posts is best laid out at night by putting down a tape or string with the intervals of the posts marked by bits of rag or sandbag tied onto it.

VI. The end of a coil of barbed wire will be found secured on the drum tucked under the standing part. In the dark it is very hard to find and release. Coils should, therefore, be prepared by daylight. A good method is to attach a piece of string to the end, uncoil the roll half a turn, re-coil it on a piece of old sandbag, and fasten it up by the string. The end of the wire can then be readily found in the dark. The pieces of tin on the wooden drums should be removed to prevent noise. It may

[1] A French method will be found in Appendix B, "Notes for Infantry Officers on Trench Warfare."

be found convenient, to make carrying easier, to re-coil the barbed wire in smaller coils on a stout stake.

VII. Pickets should be made up into bundles of one-man loads. They should be firmly tied with plain wire or brought up in sandbags. The latter is the surer way of keeping them together, at any rate with small wooden pickets. A drum of barbed wire is best carried over the shoulder, with a stout stake passed through it, which also serves for uncoiling the wire. Pickets and wire should be dumped by the carrying party outside the trench behind the center of the length to be wired.

VIII. Mauls, if used, should be muffled by nailing on a leather face or with sandbags. About eight thicknesses of sandbag material are necessary to be of any use.

IX. Equipment should not, unless necessary, be worn by wiring parties, as it is liable to cause noise.

X. Stays and holdfasts. (See fig. 1.)

Forward stays are not absolutely necessary if the entanglement posts are well driven in. They are usually required with iron screw posts, which are not very stiff unless driven in up to the bottom eye. Forward stays can not be put on, without great loss of time, until the fence on the first row of posts has been completed, for they would interfere with the fence wire being looped over the posts.

Back stays should invariably be provided and anchored well back, so as to resist any attempt to pull the entanglement away by grapnels.

Side stays at the ends of separate lengths of entanglement are usually desirable.

Pickets used as holdfasts for stays should be "staggered"—i. e., not driven in vertically, but inclined away from the post that they stay.

XI. When stringing horizontal wires for an apron on a stay or diagonal, the latter should be given a kink or bend at the places of crossing, so that there will be less chance of the wires slipping down. The horizontal wires may be secured by binding wire or by taking a bight and looping it around the stay. The coil should not be passed over and under, as this is a slow process.

NOTES WITH REFERENCE TO IRON SCREW POSTS AND PICKETS.

(*a*) The posts are 5 feet long with four eyes, the pickets are 3 feet 6 inches long with two eyes, or 15 inches long with a

loop at the end. If the ground is soft the posts can be screwed in 2 feet deep or more.[1]

(*b*) In rapid work the wire can simply be placed in the eye by forming a loop in the wire and slipping it over the post. It is not intended that the wire should be threaded through the eye. If time allows, the horizontal wires can be put on slack, and when the fence is strung the post can be given a complete turn so as to prevent the wire slipping out should it be cut, or the barbed wire may be twisted round the posts, through an eye, as it is put on, or it may be secured to the eyes by binding wire.

(*c*) To permit of the loops being slipped over the posts, it is obvious that the lowest wire in a fence must be put on first, and no forward or back stays can be fixed until the fence has been completed.

(*d*) Care must be taken that all the posts are originally screwed in so that the eyes point the same way; otherwise delays will occur in the wiring.

(*e*) Loose bundles of iron screw posts and pickets can not be carried noiselessly. It is advisable, therefore, to wrap them round with a sandbag, secured by a light turn of wire, with the ends twisted together. Enough end to this wire should be left so that it can be untwisted by hand without pliers.

(*f*) Short stakes or bats must be provided to fit the top eye of the posts in order to screw them in. The helves of the intrenching implement serve the purpose.

Examples of Wire Drills.

Picket is used to mean a short picket used as a holdfast.

Post is used to mean a longer upright.

Fence is used to mean a series of wires on a row of posts.

The conventional signs used in the diagrams are explained in figure 2.

In all the drills given, unless otherwise stated, it is assumed that—

(*a*) The length to be erected is 50 yards.

(*b*) The stores required are collected at a point behind the center of the length in a convenient order.

(*c*) The line of the fence has been marked or indicated.

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[1] Angle-iron posts are 5 feet 10 inches and 3 feet 6 inches long.

(*d*) The drums of wire are opened and the ends ready.

(*e*) Bars or sticks are run through the drums so that the wire can be uncoiled readily.

(*f*) Short sticks for screwing in the pickets are carried by the men requiring them (or mauls if wooden or angle iron pickets are used).

(*g*) All wirers have hedging gloves and wire cutters, and have their legs protected by gaiters or sandbags.

(*h*) Each number consists of two men, who work together, and the numbers commence work in succession at a suitable interval (say, four posts apart). Thus Nos. 2 move off as soon as Nos. 1 have the desired start; Nos. 3 at the same interval behind Nos. 2.

(*i*) All work is commenced on the left.

(*j*) The men who put the top wire on a fence stay the end post to short pickets.

(*k*) On completion of each operation or "duty" detailed in the drill, all men should return to a fixed place, in order to prevent confusion, if some work faster than others.

(*l*) Spare men are at hand to replace any casualties.

The drills are primarily intended for use with iron screw posts, but can be used for wooden or angle iron posts with slight modifications. If the soil permits of posts being screwed into the bottom eye, no stays are necessary, and three horizontal wires in the fence, instead of four, will be sufficient.

No estimates of stores required are given, as the distance apart of the posts and the amount of wire used must depend on what is available.

DRILL NO. 1. DOUBLE-APRON ENTANGLEMENT.

[See fig. 3.]

Working party, 12 men, exclusive of noncommissioned officers.

First duty.

Nos. 1. Lay posts in position on ground A.

Nos. 2. { Front rank—assists Nos. 1.
Rear rank—holds up posts for Nos. 3 to screw in.

Nos. 3. Screw in posts, separately.

Nos. 4. Lay front and rear pickets in position.

Nos. 5. Screw in front pickets B.

Nos. 6. Screw in rear pickets C.

Second duty.

Nos. 1. Bottom wire of fence A.
Nos. 2. Second wire of fence A.
Nos. 3. Third wire of fence A.
Nos. 4. Top wire of fence A.
Nos. 5. Front diagonal between A and B.
Nos. 6. Rear diagonal between A and C.

Third duty.

Nos. 1. Top horizontal wire on front diagonals A B.
Nos. 2. Second horizontal wire on front diagonals A B.
Nos. 3. Bottom horizontal wire on front diagonals A B.
Nos. 4. Top horizontal wire on back diagonal A C.
Nos. 5. Second horizontal wire on back diagonal A C.
Nos. 6. Bottom horizontal wire on back diagonal A C.

This drill involves Nos. 5 in "second duty" and Nos. 1, 2, and 3 in "third duty," working in front of the fence.

In the "first duty" No. 2 rear rank holds up a post for No. 3 front rank to screw in until it gets a bite in the ground. He then holds up a post for No. 3 rear rank, etc.

This obstacle and others of the same nature can be deepened by adding similar bays behind it. The posts in successive bays should cover the intervals between those in front of them. (See fig. 4.)

If two bays are made, the obstacle can be increased by tossing loose wire into the valley between the posts.

DRILL NO. 2. TRIP, FENCE, AND APRON.

(See fig. 5.)

Working party, 10 men, exclusive of noncommissioned officers.

First duty.

Nos. 1. Lay posts in position A.
Nos. 2. Hold up posts.
Nos. 3. Screw in posts.
Nos. 4. Bring up and screw in front pickets B.
Nos. 5. Bring up and screw in rear pickets C.

Second duty.

Nos. 1. Front trip wire on pickets B.
Nos. 2. Bottom wire on fence A.
Nos. 3. Second wire on fence A.
Nos. 4. Third wire on fence A.
Nos. 5. Top wire on fence A.

Third duty.

Nos. 1. Front diagonal between A and B.
Nos. 2. Back diagonal between A and C.
Nos. 3. Top horizontal wire on the diagonals A C.
Nos. 4. Second horizontal wire on the diagonals A C.
Nos. 5. Bottom horizontal wire on the diagonals A C.
Nos. 1. Have to work in front of the fence in "third duty."

DRILL NO. 3. TRIP AND FENCE.

(See fig. 6.)

Working party, 16 men, exclusive of noncommissioned officers.

First duty.

Nos. 1. Screw in posts 6 feet apart, A.
Nos. 2. Screw in pickets B and C; B first.
Nos. 3. Trip wire B.
Nos. 4. Bottom wire of fence A.
Nos. 5. Second wire of fence A.
Nos. 6. Third wire of fence A.
Nos. 7. Top wire of fence A.
Nos. 8. Diagonal wire between A and C.

Second duty.

Nos. 1. Diagonal wire between A and B.
Nos. 2. Trip wire C.
Nos. 3, Nos. 4. } Uncoil loose wire.
Nos 5, Nos. 6. } Toss in loose wire uncoiled.
Nos. 7, No. 8. } Fasten loose wire.

In the "second duty," Nos. 1 have to work in front of the fence.

Nos. 3 and 4 uncoil the loose barbed wire on the ground well clear of the entanglement. Six coils for each 25 yards.

Nos. 5 and 6 with large wooden pickets lift the loose wire and toss it on to the entanglement.

Nos. 7 and 8 spread the loose wire out and fasten it by twisting a bight at intervals to the diagonals and fence wires.

DRILL NO. 4. FENCE, WITH CROSSED DIAGONALS AND TRIPS.

(See fig. 7.)

Working party, 14 men, exclusive of noncommissioned officers.

The pickets are placed opposite the posts.

This drill involves four men working on the enemy's side of the fence.

First duty.

Nos. 1. Screw in posts A.
Nos. 2. Screw in pickets, B first, then C.
Nos. 3. Trip wire B.
Nos. 4. Bottom wire of fence A.
Nos. 5. Second wire of fence A.
Nos. 6. Third wire of fence A.
Nos. 7. Top wire of fence A.

Second duty.

Nos. 1. } Prepare posts in next length.
Nos. 2. }

Nos. 3. Front diagonal between A and B, commencing at picket B, B_1, then to A_2, B_3, etc.

Nos. 4. Front diagonal between A and B, commencing at top of post A_1, then to B_2, A_3.

Nos. 5. Back diagonal between A and C, commencing at picket C_1, then to A_2, C_3, A_4, etc.

Nos. 6. } Back diagonal between A and C, commencing at top
Nos. 7. } of post A_1, then to C_2, A_3, etc.

DRILL NO. 5. SUCCESSIVE ROWS OF FENCES.

(See fig. 8.)

Working party, 12 men, divided into four groups of 3 each, W, X, Y, Z.

The posts must be prepared by attaching binding wire to the bottom eye, to this the vertical diagonals between the fences are made fast.

First duty.

Group W. Lay out posts in row B.
Group X. Screw in above.
Group Y. Lay out pickets in row A.
Group Z. Screw in above.

Second duty.

Group W. Lay out posts in row C.
Group X. Screw in above.
Group Y. Bottom wire of fence B.
Group Z. Trip wire on row A.

Third duty.

Group W. Second wire on fence B.
Group X. Third wire on fence B.
Group Y. Top wire on fence B.
Group Z. Front diagonal between A and B.

Fourth duty.

Group W. Bottom wire of fence C.
Group X. Second wire of fence C.
Group Y. Third wire of fence C.
Group Z. Top wire of fence C.

Fifth duty.

Group W. Diagonal between B and C, bottom of C_1 to top of B_1, bottom of C_2, etc.

Group X. Second diagonal between B and C, top of C_1 to bottom of B_1, top of C_2, etc.

Group Y. Lay out and screw in pickets D; or lay out row of posts D, if the fences are to be continued.

Group Z. Diagonal between C and D; or screw in above, etc.

In "third duty" Z and in "fifth duty" W and X work on enemy's side of fence.

In "fifth duty" W and X loop the diagonals over top of pickets and make them fast to the bottom eye by binding wire.

Instead of putting the criss-cross diagonals between fences B and C as above, which involves binding wire and takes some

little time, it would be sufficient if time presses to stay the pickets merely by connecting the heads. (See fig. 9.) "Gooseberries," etc., can be thrown into the space between B and C.

Another variation is to put loose wire or French wire between fences B and C and criss-cross plain wire to connect the tops of the pickets. (See fig. 10.)

A further variation can be introduced by placing the posts so as to form squares instead of triangles. (See fig. 11.)

DRILL NO. 6. DOUBLE FENCE.

(See fig. 12.)

Working party, 28 men, exclusive of noncommissioned officers.

This entanglement is designed for stout wooden posts well driven in or screw posts screwed in down to the bottom eye; no hold-fast pickets are then required.

The drill only requires one duty from each pair of men.

The apron is of a different pattern to those previously given; the wires miss alternate pickets.

Three horizontal wires can be used for the fence instead of the "gate" pattern shown.

Order of work.

Under superintendence of two noncommissioned officers, all hands carry up and place the posts on the ground.

No. 1 drive or screw in posts in front fence A.
No. 2 drive or screw in posts in back fence B.
No. 3 bottom wire 3 of fence A.
No. 4 diagonal wire 4 of fence A.
No. 5 diagonal wire 5 of fence A.
No. 6 top wire of fence A.
No. 7 bottom wire 3 of fence B.
No. 8 diagonal wire 4 of fence B.
No. 9 diagonal wire 5 of fence B.
No. 10 top wire 6 of fence B.
No. 11 apron wire 11.
No. 12 apron wire 12.
No. 13 apron wire 13.
No. 14 festooned wire 14.

DRILL NO. 7. ORDINARY LOW ENTANGLEMENT.[1]

(See fig. 13.)

Working party, 30 men, in 10 groups, with a noncommissioned offier.

Group A, front row of pickets A.

Group B, straight wire A row of pickets.

Group C, second row of pickets C.

Group D, zigzag wire A_1, C_1, A_2, C_2, etc.

Group E, loose wire on zigzag A_1, C_1, A_2, C_2, etc.

Group F, straight wire on C row of pickets.

Group G, third row of pickets G.

Group H, zigzag wire G_1, C_1, G_2, C_2, etc.

Group J, loose wire on zigzag G_1, C_1, G_2, C_2, etc.

Group K, straight wire on G row of pickets.

Pickets may be 12 to 18 inches out of the ground and 3 feet apart.

DRILL NO. 8. FRENCH WIRE OBSTACLE.

(See fig. 14.)

The obstacle consists of two rows of French wire, placed just far enough apart for a man to pass between them. Each coil is stapled down in five places—at each end, and at one-fourth, one-half, and three-fourths of its length. When two coils meet, the same staple fastens down both coils.

Posts 5 feet long are driven through the center of the coils in five places, as in the case of the staples; the ends of adjoining coils are interlaced a little so that the post will go through both.

A strand of barbed wire is run along the top of each row and fastened to the posts with a round turn. It is pulled as taut as possible and twisted on to the French wire by a staple, peg, or wire cutters, close to each post, and in several places between the posts.

One or more strands of barbed wire are run along to the front as an "apron."

Diagonal wires are run from the tops of posts of the front row to tops of posts of second row.

Working party, 24 men in three parties, with noncommissioned officer.

---

[1]A low entanglement is not, as a rule, sufficient by itself but may be combined with a high entanglement. (See figs. 15, 16, 17, 18.

Front row.

Party A. 1 holds end of French wire and staples it down; 2 pulls wire out 20 yards; 3 shakes wire clear of obstructions and put in staples one-fourth, one-half, and three-fourths way long.

Party B. 1 mauls in anchorage pickets and posts; 2 holds posts; 3 supplies posts.

Party C. 1 uncoils barbed wire; 2 makes fast end to anchorage and twists wire round tops of pickets; 3 twists barbed wire on to the French wire.

Party D. 1 runs coil of barbed wire along the front; 2 and 3 twist it onto the front of the French wire.

Back row.

Party E. Same as A.

Party F. Same as B.

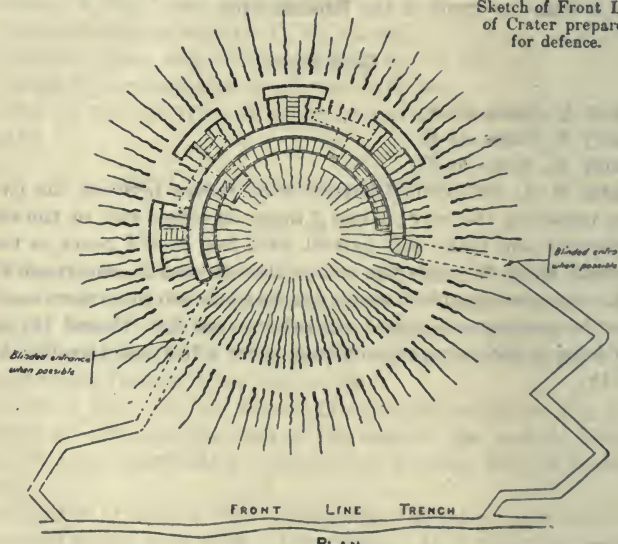
Party G. Same as C.

Party H. 1, with coil of barbed wire, moves between the two rows, uncoiling the wire; 2 and 3 move on either side of the entanglement and make this barbed wire fast to the posts as the diagonal, while H_1 holds the coil so that H_2 and H_3 can reach it.

The obstacles described above can be combined in various ways either by placing one behind the others (see figs. 15 and 16) or by placing a high wire entanglement over a low one (see figs. 17 and 18).

PLAN

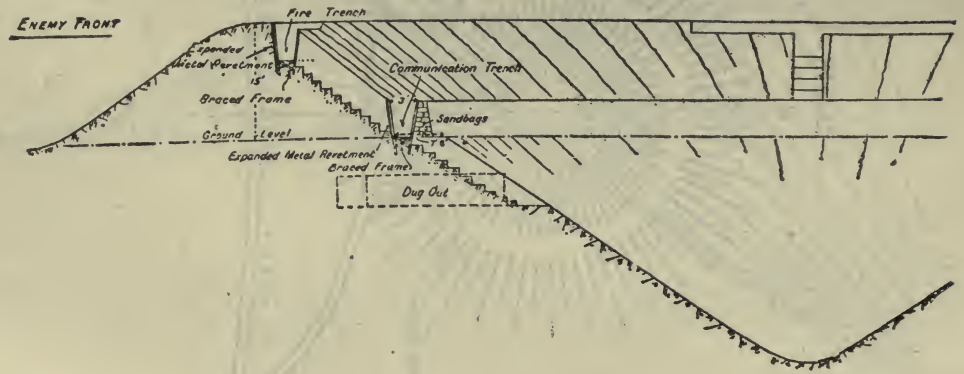
Plate A.
Sketch of Front Lip of Crater prepared for defence.



PLAN.

ELEVATION

Approx. Scale 1" = 12'.



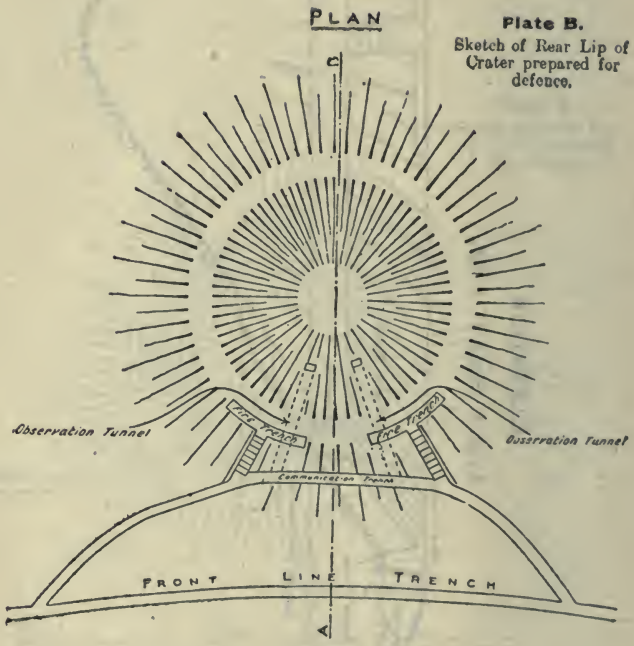
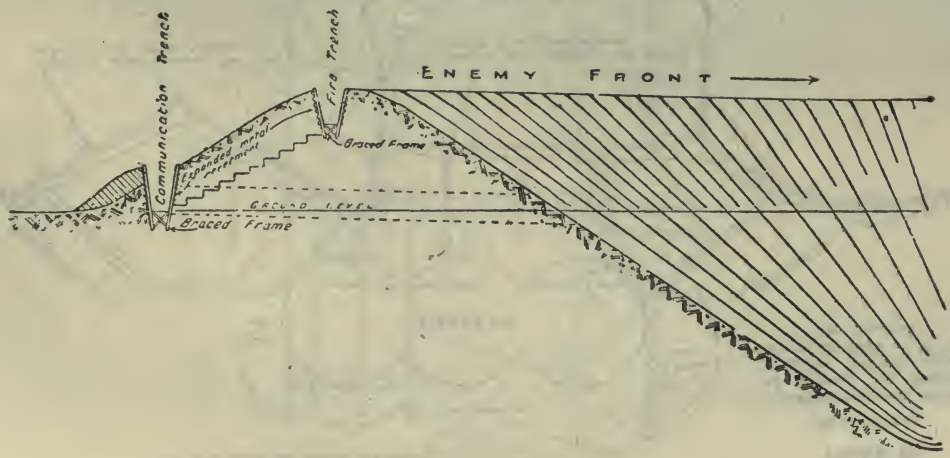


Plate B.
Sketch of Rear Lip of Crater prepared for defence.

SECTIONAL ELEVATION ON A.B.

Approx. Scale 1" = 24'.



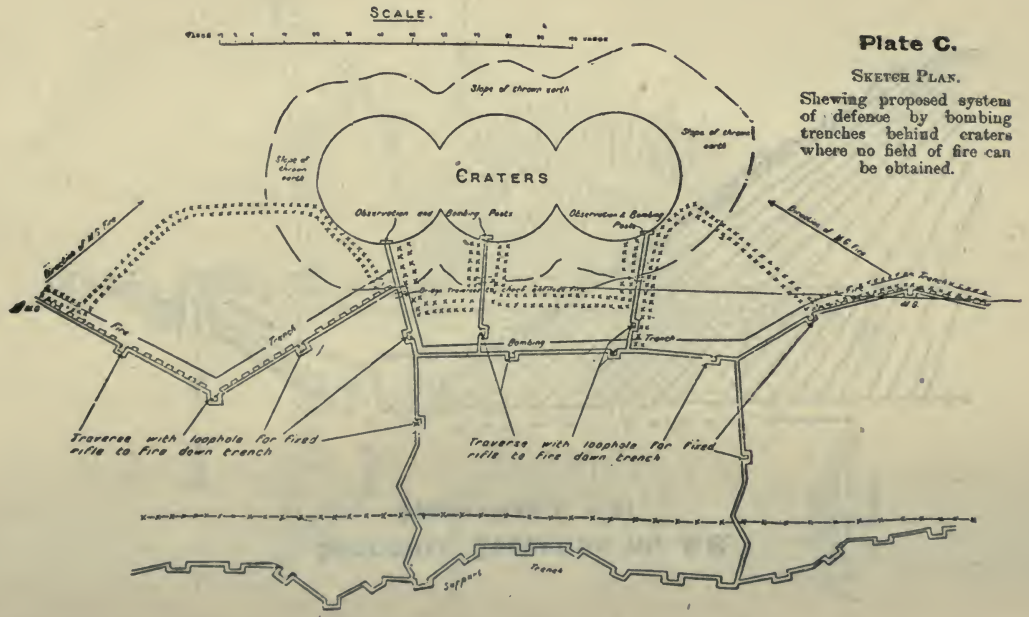
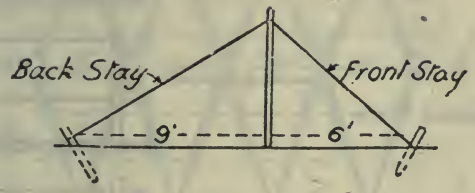


Plate C.

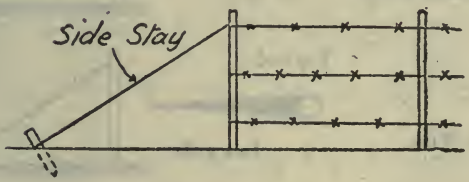
SKETCH PLAN.

Shewing proposed system of defence by bombing trenches behind craters where no field of fire can be obtained.

FIG. 1.



SECTION.



ELEVATION.

Fig. 2.

CONVENTIONAL SIGNS USED IN PLATES.

PLAN. ELEVATION.

Posts (long).

Pickets (short).

In fence.

1 Horizontal Wire.

2 Horizontal Wires.

4 Horizontal Wires.

Top end.

Inclined Wire.

Low end.

Gate.

Gate and 2 Horizontal Wires.

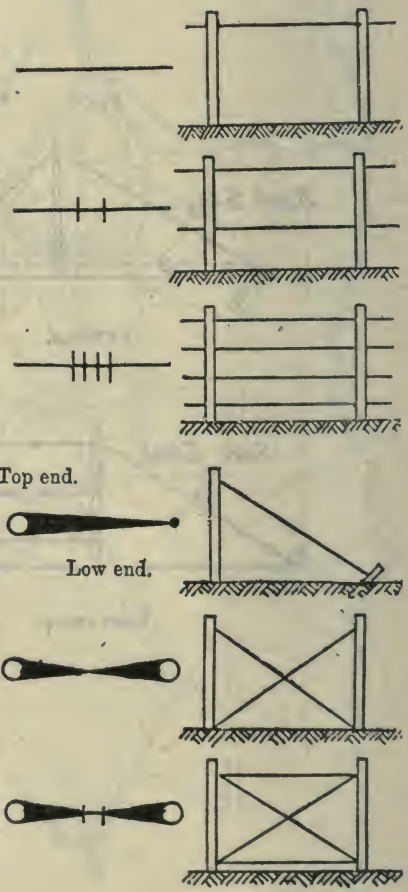


Fig. 3.

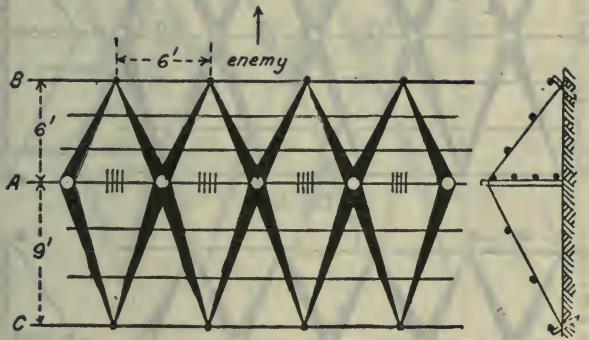
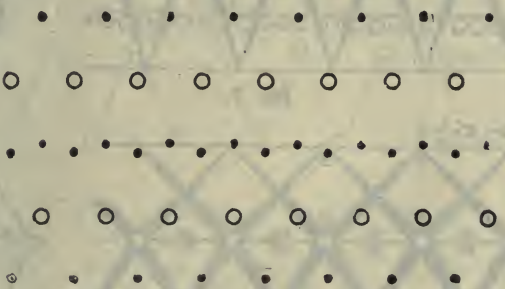


Fig. 4.



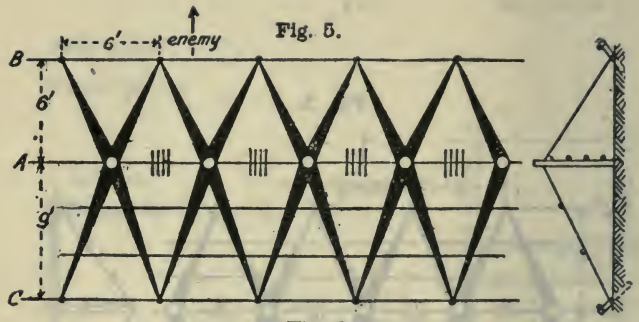


Fig. 5.

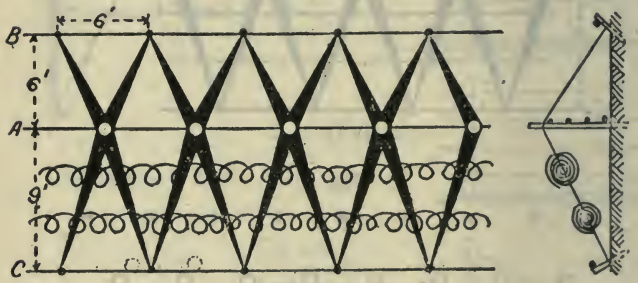


Fig 6.

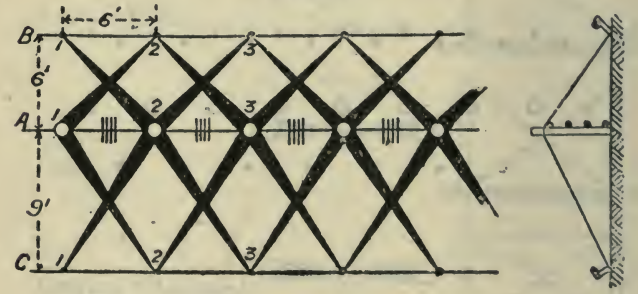


Fig. 7.

Fig. 8.

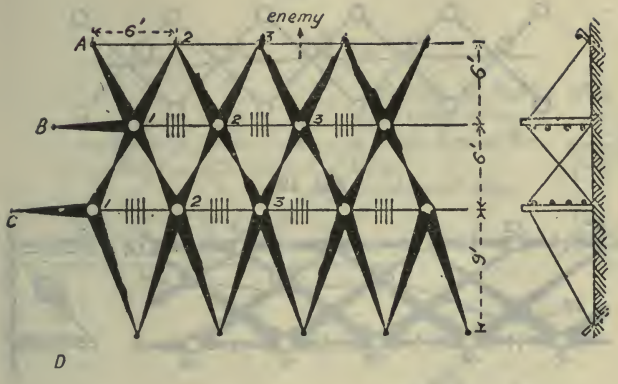


Fig. 9.

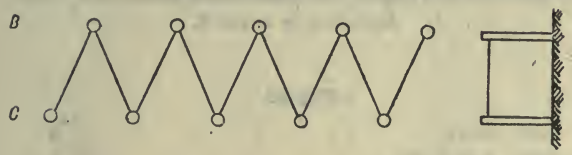


Fig. 10.

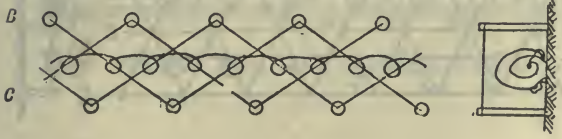
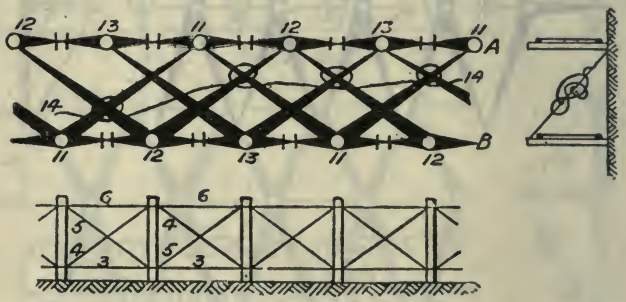


Fig. 11.

Fig. 12.



Elevation of A and B.

Fig. 13.

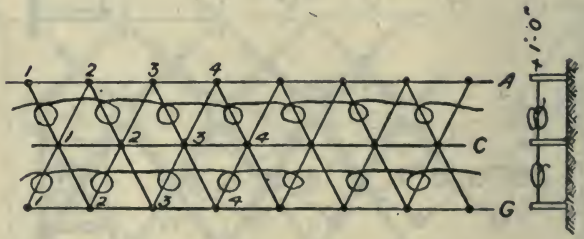


Fig. 14.

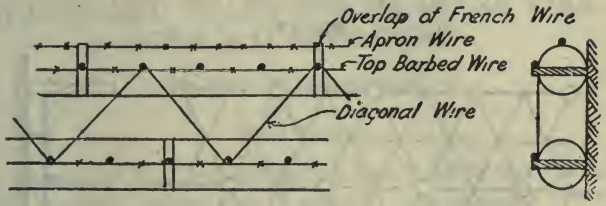
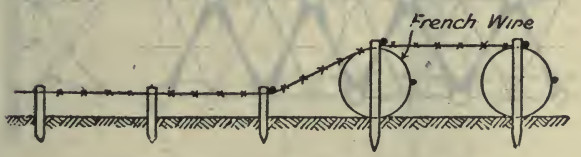


Fig. 15.

Fig. 16.



COMBINED HIGH AND LOW ENTANGLEMENTS.

Fig. 17.

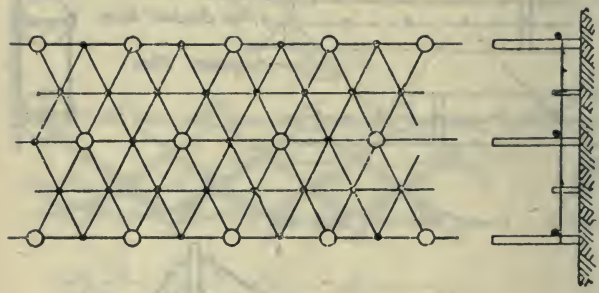
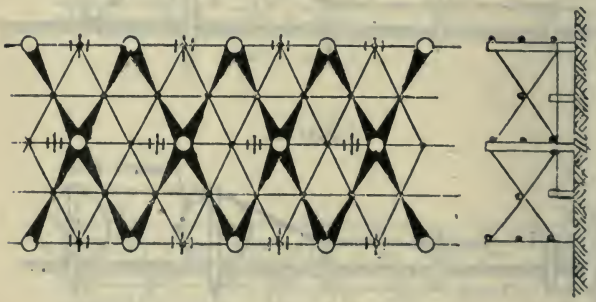


Fig. 18



NOTES AND RULES FOR BARRAGE FIRE WITH MACHINE GUNS.

(Issued by the General Staff.)

DEFINITIONS.

A barrage of fire produced by machine guns is intended primarily to deny a certain area of ground to the enemy by preventing him crossing one or all of the lines which bound it. A barrage, therefore, may be frontal or flanking (with regard to our own line), or both simultaneously.

FIGURE I.—Frontal barrage.

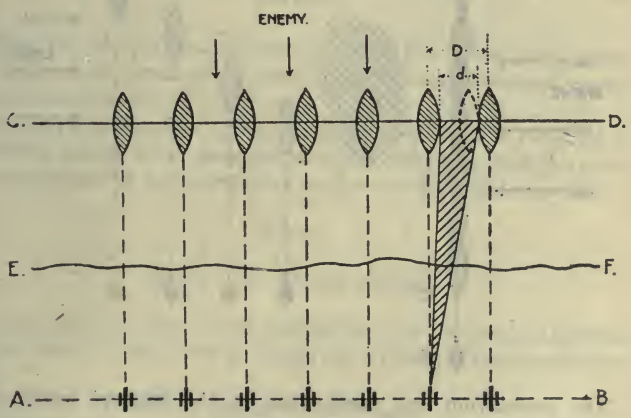


FIGURE II.—Oblique barrage.

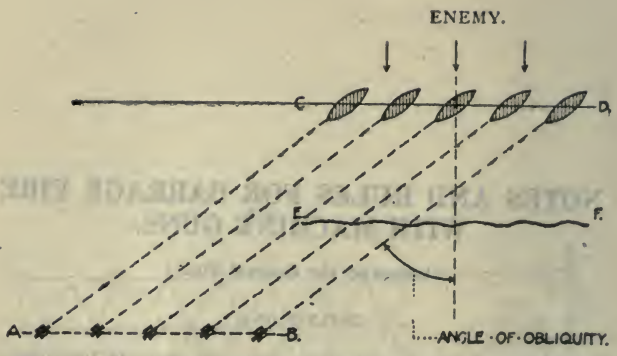
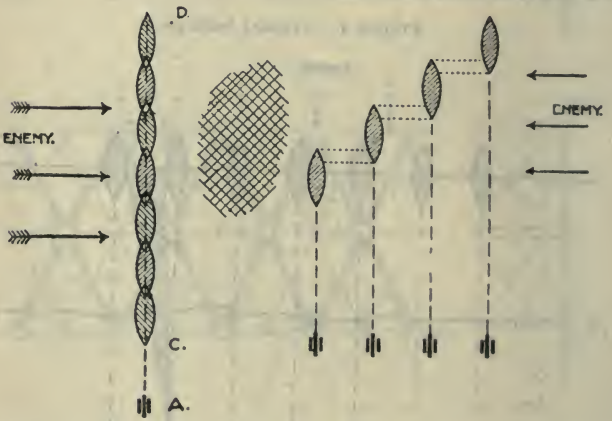


FIGURE III.—Flank barrage.



The production and application of the integral parts of a barrage—i. e., of the consecutive zones from the guns engaged—present no new problems at all. The ordinary methods of fire direction for engaging a visible or an invisible target apply with no modification whatever.

GENERAL NOTES.

(*a*) Limits of front each gun can cover:

There is a lower limit and an upper limit to the front which each gun can cover in producing a barrage.

The lower limit will produce a barrage of high efficacy, comparable in effect to a dense artillery barrage, which should cause (on flat ground) somewhere about 50 per cent casualties to a hostile body of troops passing through it.

The upper limit produces the minimum thickness barrage which can be applied conveniently without gaps.

These two limits really define the opposite ends of a scale between which the machine-gun officer can operate, choosing whatever degree of efficacy of barrage he may consider necessary to meet the tactical situation, or to produce the most efficient barrage with the number of guns at his disposal.

(*b*) As a rough guide, the number of rounds to be fired per burst may be taken as twice the first two figures of the range in yards.

Example: Range, 2,100 yards; 40-round bursts.

REMARKS.

This type of barrage, produced by using the upper limit, might be required, for instance, to stop definitely any attempted enemy counterattacks, etc.

This type of barrage might be employed when it is required to deter the enemy from manning parapets, escaping over the open, or making use of any particular area of ground, etc.

RULES.

Rule I. For frontal barrage.

Lower limit is obtained by multiplying the gradient of descent of the bullet at the range at which the barrage is being produced by 4.

Upper limit: Seventy yards for all ranges.

Example: Range is 2,100 yards.

From Table I, column 3 (vide Infantry Machine-Gun Company Training), gradient of descent, 1 in 5.5.

Lower limit = $4 \times 5.5 = 22$ yards per gun.

Upper limit = 70 yards per gun.

Rule II. For oblique barrage.

Lower limit is obtained by multiplying the gradient of descent of the bullet at the range at which the barrage is being produced by 4.

Upper limit: For all ranges, 70 yards plus 2 yards for each degree of obliquity (vide fig. II) up to a maximum of 150 yards, which must not be exceeded.

Example: Range, 2,100 yards; degree of obliquity, 45°.

From Table I, column 3 (vide Infantry Machine-Gun Company Training), gradient of descent, 1 in 5.5.

Lower limit $= 4 \times 5.5 = 22$ yards per gun.

Upper limit $= 70 + (2 \times 45) = 70 + 90 = 160$.

This is over 150, therefore 150 yards must be taken.

NOTES.

On Rule I. For frontal barrage.

(*a*) Traversing must be employed, but there is no advantage gained by searching if only a curtain of fire is required.

(*b*) If the ground slopes down and away from the guns, both limits may be increased, and vice versa.

On Rule II. For oblique barrage.

(*a*) Traversing must be employed, but there is no advantage gained by searching if only a curtain of fire is required.

(*b*) If the ground slopes down and away from the guns, both limits may be increased, and vice versa.

RULES.

Rule III. For flank barrage.

In this case the limits become the actual differences in sighting elevation to be used on the guns.

Lower limit is obtained by multiplying the gradient of descent of the bullet at the range at which the barrage is being produced by 4.

Upper limit, 150 yards for all ranges.

Example: Range to nearest zone, 2,100 yards.

From Table I, column 3 (vide Infantry Machine-Gun Company Training), gradient of descent, 1 in 5.5.

Lower limit $= 4 \times 5.5 = 22$ yards.

Upper limit $= 150$ yards.

I. e., for high efficacy, combined sights with 25 yards differences; for thin but continuous, 150 yards differences.

Rule IV. Only for ranges below 1,300 yards.

Use the upper limit only, as given in Rules I, II, and III, for all ranges below 1,300 yards.

Example: Range, 1,200 yards; frontal barrage, front, per gun, 70 yards.

NOTES.

On Rule III—for flank barrage.

(*a*) It should be observed that the danger line, through which an enemy has to pass, is much less in thickness in flank than in frontal barrages, as in the latter case we are dealing with the width of the zone, whereas in the former we are concerned with the depth. Therefore it takes a much shorter time for a man to pass through, and this emphasizes the necessity for continuous fire in flank barrages.

As the number of guns required is not excessive, and others may, therefore, be available, if a high degree of protection is desired, a second barrage should be formed, parallel to the first, with, say, 50 yards separating them. The two should not be superimposed, because if by reason of any ground formation or artificial cover a part of the ground was defiladed in the first barrage, it is probable that such defilading effect would not exist at the same distance from the guns and a little way to a flank. In other words, gaps formed as indicated above in both barrages would probably be staggered, thus rendering the combined barrage continuous throughout its length.

(*b*) It should be noted that the rules for "combined sights" do not apply to this type of fire, e. g., in this case differences of 25 yards or 150 yards are permissible.

On Rule IV.

Reason: That although the rule for obtaining the lower limit is theoretically correct, it gives large frontages, which each gun can cover when the range is below 1,300 yards. The influence of ground (i. e., slight obstacles, undulations, etc.) here becomes so great that it is not advisable to use such large frontages.

MODIFICATIONS DUE TO RATE OF FIRE, SPEED OF HOSTILE ADVANCE, ETC.

(*a*) The rules given are applicable without alteration to all cases where the ratio—

$$\left\{\begin{matrix}\text{Rounds fired by each gun in one minute} \\ \text{Speed of enemy advance in yards per minute}\end{matrix}\right\} \text{is equal to } 4.^1$$

(*b*) If each gun is firing 300 rounds per minute (about its maximum), the rules then will apply for a speed of advance of about 2½ miles an hour.

(*c*) If the pace, owing to bad ground, etc., is less (than 2½ miles per hour), then each gun can fire fewer rounds per minute and still produce the same degree of efficacy of barrage. (See example.)

(*d*) If you have fixed beforehand the number of rounds to be fired by each gun per minute, and if you have estimated the probable speed of advance, the ratio (see No. 1, above) will show you how to modify the rules to meet any particular case. (See example.)

REMARKS AND EXAMPLES.

(*a*) The factor 4, which is given in the rules, is a good safe figure to use and should be used in all cases where there is no time to make further calculations.

(*b*) For example, 2½ miles an hour=about 75 yards per minute $\left\{\begin{matrix}300 \\ 75\end{matrix}\right\}=4.$

(*c*) e. g., speed of advance, estimated at not more than 1½ miles an hour, owing to mud, etc., this equals 44 yards per minute.

Number of rounds to be fired by each gun per minute can therefore be found:

$$\left\{\begin{matrix}\text{Number of rounds per minute} \\ 44\end{matrix}\right\}=4.$$

I. e., number of rounds per minute=4×44=176 (or thereabouts).

(*d*) Example—frontal barrage:

Guns are to fire each 250 rounds per minute. Enemy speed estimated at not more than 1½ miles per hour.

1½ miles per hour=44 yards per minute.

The ratio becomes $\left\{\begin{matrix}250 \\ 44\end{matrix}\right\}=5.7.$

Your lower limit is now 5.7 times the gradient (instead of 4 times the gradient) for the range.

Your upper limit is now $70\times\left\{\begin{matrix}5.7 \\ 4\end{matrix}\right\}=100$ yards (instead of 70 yards) for any range.

[1] This is the figure used for determining the front per gun in the rules.

GERMAN INSTRUCTIONS FOR THE EMPLOYMENT OF FLAME PROJECTORS.

(A) Troops and Equipment.

1. Flame projectors (Flammenwerfer) are a new weapon for trench warfare. The third guard pioneer battalion (6 Companys) has been equipped with them and trained in their use. They are under the command of general headquarters, and will be placed at the disposal, as a unit or by sections, of particular formations for a particular purpose, when they will for the time being be entirely under the orders of the responsible commander, who, after consulting with the flame projector commander and taking the limitations of the weapon into consideration, will give the tactical orders for the assault. The responsibility for their technical employment rests entirely with the flame-projector commander.

2. Each company of the third guard pioneer battalion is equipped with 20 to 22 large flame projectors (range of jet, 33 to 44 yards). They will be built into sapheads, advanced galleries, or the front-line position. In addition, each company has 18 small flame projectors (range of jet, 16 to 19 yards). These are easily portable and will be carried on the back.

(B) Capabilities of Flame Projectors.

3. During a flame attack each large flame projector (built in at about 27 yards distance from the enemy's trench) will cover the enemy's foremost trenches with flame on a front of about 55 yards. The enemy in these trenches will either be destroyed or driven off, or if he happens to be in deep dugouts will have his morale so shaken that he will allow himself to be captured without resistance. Machine guns, even if provided with overhead cover or in blockhouses, are put out of action by directing the flames against the loopholes. The flame attack lasts about one minute.

4. The front covered by a company of the third guard pioneer battalion is about 1,100 to 1,640 yards. The effect, physical and moral, of such a flame attack on the enemy is very great.

5. The assault will be made by infantry and pioneers immediately after the flame attack. Detachments with small flame projectors will accompany the assaulting troops in order to overcome any resistance which may be offered by blockhouses, etc., and also to spread the fear of the flames to the enemy's rearward positions. Many successive positions can often be taken by assault at the same time.

6. The small portable flame projectors may also often be employed with advantage in combination with bombers in making progress in the enemy's trenches, and for flank attacks on portions of trench, etc.

(C) Necessary Conditions for Flame Attacks.

7. For large flame projectors, trenches, sapheads and galleries must have been pushed forward to within 27 yards, at least, of the enemy's position at several points, or there must be a prospect that they will be able to approach so near within the next few days.

8. For small flame projectors, the portions of trench referred to in paragraph 6 must be approached under the cover of trenches or saps.

9. In both cases (pars. 7 and 8) an accurate previous reconnoissance of the points at which the flame projectors are to be employed and of the approaches to them is absolutely essential. This must be made by the officers of the flame-projector battalion. The reconnoissance, transport of the apparatus, and other preparations take, as a rule, several days. The building in of the large flame projectors requires 12 hours and can be done without the enemy becoming aware of it.

10. The direction of the wind has very little influence on the effect of a flame attack. A postponement of an attack will become necessary only if there is a very strong head wind.

(D) Tactical Employment of the Flame Projector Detachment.

11. Flame projectors must be used offensively. It is forbidden to build flame projectors in as defensive weapons in the foremost lines. Small flame projectors may be used, however,

to drive off counter attacks against positions, the capture of which has been facilitated by a flame attack, until such positions have been consolidated. For technical reasons they cease to be effective after about 48 hours. In other special and quite exceptional cases, when it is proposed to use them defensively, the commander of the flame-projector detachment should be consulted beforehand.

12. Flame attacks proper (i. e., sudden attacks with a number of large flame projectors without any special preparation by artillery and trench mortars) should be the usual method of employment. The assaulting troops (infantry, pioneers, and the small flame projectors) must advance at once (i. e., 1 minute after the large flame projectors have come into action) and take every advantage of the panic caused in the enemy's ranks by the flame attack, with a view to capturing the second and third-line positions. (For the action of the artillery and trench mortars, see par. 35.)

13. If the commander of the flame-projector detachment considers it safe to do so, one or more sections of the front to be attacked may be left untouched by the flames between the areas covered by the individual large flame projectors which have been built in. The length of such sections may be 100 yards or even more.

14. The fact that the enemy is taken by surprise by the flame attack has much to do with making it a complete success. It is therefore of the highest importance that the enemy should not obtain information of the arrival of a flame-projector detachment in the division, etc., or of the sector in which it is intended to employ it. It is consequently necessary that the word "Flammenwerfer" should never be mentioned during a conversation when speaking over the telephone or in orders. A code word is to be used, such as "neue minenwerfer," or something similar. The detachment will not be spoken of as a "Flammenwerfer" company, but as —th company, third guard pioneer battalion.

(E) General Tactical Instructions.

15. When giving orders for an attack in which large flame projectors are to be employed, the following points, based on previous experience, should be considered:

(i) Objective.

16. Exact instructions must be given how far the attack is to be pushed under the most favorable conditions. It has happened that our troops, taking advantage of the panic of the enemy, have carried the advance too far, thereby coming under our own artillery barrage.

17. In order to insure secrecy as much as possible it is advisable that the intended operation should be denominated by a code word (in writing or when using the telephone), such as "vortrag," "vorführung," "verhandlung" (lecture, production, negotiation).

(ii) Time of attack.

18. As a rule, half an hour, or on dull days one hour, before sunset is the most suitable time. Only in exceptional cases, when, in the course of the day, the destruction, by artillery or trench mortars, of the large flame projectors which are built in appears to be fairly certain may the attack be carried out in the early morning.

19. It is sometimes advisable that the day and hour should not be mentioned in the orders for the attack, but should temporarily be kept secret, and should be referred to as "X" and "Y." In later orders, which will be issued in writing only to battalion, artillery, and group commanders and the commanders of independent companies, inclusive, the time should then be indicated—for instance, as follows: "X" equals 27th November; "Y" equals 3.20 p. m.

(iii) Assaulting troops.

20. The carrying out of the preparations for the attack is often better done if the assault is not made by the troops occupying the trenches, but by a detachment which has been kept in rest billets. All troops which up to that time have been in the trenches will then retire to the second position shortly before the assault, and as soon as the attack by the assaulting party has begun again move forward into the foremost trenches previously held by them, in order to hold a possible counterstroke.

21. The size of the assaulting force must not be too great. The calculation should be one (man?) of the assaulting party

to each meter of front. Each party must have a good second in command in addition to the commander.

22. The individual assaulting columns will be distributed in four successive waves, as follows:

(*a*) Assaulting party, which advances immediately after the flame attack and occupies the enemy's positions. In this party are included bombers, engineers (for the demolition of obstacles), and small flame projectors.

(*b*) Consolidating party for the consolidation of the enemy's trenches.

(*c*) Communication-trench construction party, to construct communication trenches from the captured trenches to our previous foremost position.

(*d*) Carrying party, which will take forward material for obstacles, especially knife rests, sand bags, hand grenades, and ammunition.

The attacking parties on the flanks will have several bombing parties and small flame-projector detachments attached to them to assist them in clearing the trenches from the flanks.

23. Assaulting detachments and consolidating parties will take up positions in the saps or in the front-line trenches; communication trench and carrier parties will be ready behind them in the communication trenches. The stationing of troops in readiness will of course depend upon the existing system of saps, and will sometimes necessitate previous reconstruction of this system.

24. The division of the assaulting columns into these parties is best carried out well behind the front. If no other troops are to be employed except those manning the trenches, it is advisable to relieve them, for a short period at least, from the foremost trenches for the purpose of preparation and organization. The troops will march up to their positions in the line in the order detailed for the assault.

(*iv*) *Preparations for the assault.*

25. Special preparations must be made in order that the assaulting troops can mount the parapet rapidly. Short ladders with one pole about 1 meter longer than the other are the most useful means. These should be made previously in the engineer parks. One ladder is required for every three to four men of the assaulting party. When being taken up to the front

line they must be carried horizontally. They must not be placed in position in the trenches until the commencement of the flame attack.

26. All necessary material, such as hand grenades, loophole plates, sandbags, knife rests, barbed wire, entrenching tools, and light pistols with ammunition must be kept in readiness either in the communication trench depots or with the assaulting columns.

27. Communication trenches and approaches must be divided up and allotted to the assaulting columns and reserves. Communication trenches, saps, etc., will be distinctly marked with numbers, letters, or names.

28. Should other troops than those holding the trenches be employed for the assault, their officers and noncommissioned officers must carry out a thorough reconnaissance of their trenches in the early dawn and during the day. No unusual movement, however, must take place in the trenches and there must be no loud talking.

29. The advance of the assaulting troops into the front-line trenches and the relief of the troops in the trenches must be carried out in complete silence. No talking is to be allowed. Unnecessary crowding together should be avoided. Bayonets will be fixed behind the lines and not in the front line. Rifles must be carried at the trail as far as possible.

(v) The assault in conjunction with a flame attack.

30. Charges (long or concentrated), to create gaps in our own obstacles, will be exploded by the engineers at the earliest 15 minutes before the flame attack, and this work must be completed 10 minutes before the flame attack. It will often be found sufficient if, on the night previous to the attack, the engineers cut the wire which connects the knife rests in front of the foremost trenches. This must be done without attracting attention, the knife rests being left in their original position until the troops are ready to attack—i. e., immediately after the flame attack—when the engineers will precede the assaulting force, swinging the knife rests round lengthwise at right angles to the parapet.

Engineers will also hurry forward and make gaps in the enemy's wire, should these not have been made previously by trench mortars or engineer detachments. Obstacles which are not too strong can very often be easily crossed by the assault-

ing troops, as after a flame attack the enemy fires very little or not at all.

31. The duration of the flame attack is only one minute. The signal for it is given by a siren whistle, or at a given time, watches having been previously synchronized. The assaulting troops must be instructed that they have nothing to fear from the flames and smoke, nor need they fear that they may themselves be caught by the fire jet, as this is cut off by simply turning a tap previous to their advance. They must understand that they can advance immediately after the cessation of the spray without danger, as small bursts of flame on the ground or in the enemy's trenches will burn out at once, and a little fire on the ground is at once extinguished when trodden upon. It is most important to impress upon the troops that the assault is much facilitated by the use of the flame projector, as it has been proved by experience that the enemy fires very little or not at all after a flame attack.

32. The assault is made immediately after the flame attack. The assaulting party charges, followed closely by the consolidating party. The small flame projectors allotted to the assaulting party attack any machine guns that are still in action, blockhouses that are still being defended, etc., with short spurts of fire. They are at the disposal of the commander of assaulting party for this purpose.

It is of the highest importance to drive out the enemy simultaneously to a considerable distance on both flanks by means of bombing and flame-projector detachments (see par. 22) and to construct sandbag barricades at these points. Communication trenches which lead into the captured position must also be cleared for a certain distance and blocked by constructing sandbag barricades about 27 yards forward of the position won.

The action of the communication-trench construction party will commence immediately after the nearest enemy position has been taken. Material is brought up as soon as possible by the carrier party, which will continue to bring up fresh material from the rear as required. Carrier parties can at times on their return journey also take charge of prisoners as far as the point at which the reserves are situated in rear.

It is especially important to bring up and dig in machine guns immediately.

33. It may be of advantage to order a password for our attacking troops, especially if several successive positions are

to be taken, and in the twilight of dull days. Words which the enemy would find it difficult to pronounce are particularly suitable, such as "Schweineschmalz," "Stiefelwichse," etc.

(*vi*) *Action of the artillery and trench mortars.*

34. In a flame attack pure and simple, which is generally to be preferred (see par. 12), the action of the artillery and trench mortars will not commence until about one minute after the projection of the flames, when the more retired positions, which it is not intended to take, should be shelled. Barrage fire will be opened on the ground behind these positions and on the communication trenches, etc.

35. Should it be impossible, in exceptional circumstances, to dispense with previous preparation by the artillery and trench mortars, only the enemy's rear positions, and not his foremost positions, are to be shelled. It does not matter if this results in the enemy pressing forward into the positions nearest to us in order to obtain shelter, thereby reinforcing the garrison. It must, however, always be borne in mind that by artillery and trench mortar preparation the enemy is warned of an imminent attack, and is thus enabled to take precautionary measures.

36. In most cases, however, it is advisable to request the divisions on the right and left to open with artillery on the enemy's rear positions behind the front which it is intended to capture. Registration must be carried out so as not to attract attention.

37. As a rule it is advisable to detail a special artillery group to repulse hostile counter attacks. Its commander must take up his position with the commander of the attacking force and must arrange for special telephonic communication.

(*vii*) *Forces on the flanks of the front of attack.*

38. The effect of a flame attack is sometimes felt to the right and left of the front which is covered with flame. Our troops which are posted on the flanks of the actual front of attack can sometimes, therefore, gain ground by a prompt advance in force. It is, consequently, necessary to keep under close observation the enemy's troops on the flanks of the front of attack, and, according to circumstances, either subject them

to a heavy fire or attack them as well. Engineer detachments are to be posted in readiness for forming gaps through the obstacles, should this be necessary.

(viii) Equipment, ammunition, and rations.

The assaulting troops will wear "assault order." Each man will take his great coat, tent square, mess tin, full water bottle, four days' rations in his haversack, and, in addition, at least 200 rounds, two hand grenades, and rifle with fixed bayonet.

The consolidating parties are similarly equipped, except that they sling their rifles (bayonets not fixed). Each man will carry a loophole plate, 50 sandbags, and heavy entrenching tool.

Communication trench and carrier parties will appear in their usual order of dress. Only the noncommissioned officers will carry rifles. The men of the communication trench party will each carry a heavy entrenching tool, 50 sandbags, and at least two hand grenades.

(ix) Telephone communications.

40. A number of infantry telephone lines will be laid from the captured position to the rear immediately after the assault.

47. All lines leading to the commander of the attacking force are to be used solely for service messages which concern the attack, so that he can bring his personal influence to bear upon every part of the front.

ADDITIONAL REMARKS BY FOURTEENTH RESERVE CORPS.

(Fourteenth Reserve Corps headquarters, Ia No. 629, secret, dated Apr. 28, 1916.)

On March 23, 1916, attention of the divisions was called to the fact that information had been received from the Moritz listening apparatus as to practice by the British with flame projectors and lachrymatory bombs (corps headquarters, Ia No. 451, secret, dated Mar. 23, 1916). During the raid against the Ninety-ninth Reserve Infantry Regiment on the night of April 22–23, 1916, lachrymatory bombs were employed. The enemy continues to practice with flame projectors behind his front. Moritz listening post No. 52 reports on such a practice for the 29th of this month. It is quite possible that the enemy intends shortly to use this weapon against us. Whether he will combine his flame

attack with artillery fire is doubtful. It is not absolutely necessary.

The troops are to be instructed as to the special features of this new weapon (corps headquarters Ia No. 1505, secret, dated Dec. 19, 1915). Flame projectors which have been built in in the enemy's positions (see par. 2 of the above-mentioned order) must be destroyed as soon as possible by concentrated artillery fire. The small portable projectors constitute a danger to the enemy's own troops if the men carrying the apparatus are hit. Every effort must be made to do this.

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